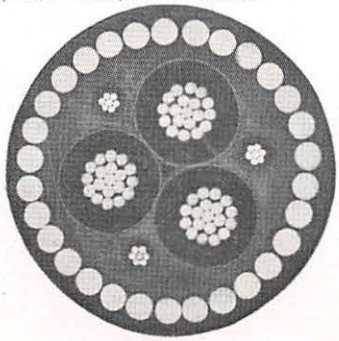
JULY, 1968

Railway Signaling & Communications

on guard

This is a nest of grouse eggs. A nest is a fragile concatenation of twigs, built by a delicate creature with no hands, but it is built to do a job, and it does that job to perfection. Within one classic circle, a nest is a home, a bed, and a protective shelter.

Below is a "plan" of a Kerite cable. Cables may look alike in cross-section, but a Kerite cable is as different from other cables as a nest is from random twigs. Kerite is built to do its job to perfection. Only the right combination of proved materials, engineering, experience, and technique makes it possible. The Kerite Company, 30 Church Street, New York, N. Y. 10007.



Kerite

the cable that lasts...and lasts...and lasts...

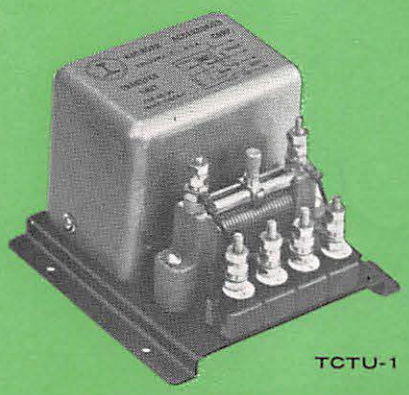
Simmons-Boardman **TIME-SAVER** Publication

RACO

POWER SUPPLY and TRANSFER UNIT

FOR AC-DC TRACK CIRCUITS

TCPS-1



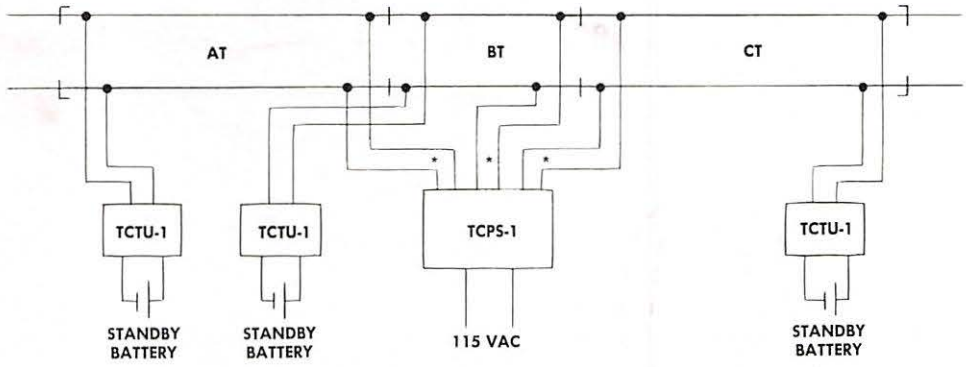
TCTU-1

This equipment provides the high shunting sensitivity for the AC-DC track circuit required for light traffic lines in combination with an automatic transfer to standby battery in event of AC power interruption.

RACO TCPS-1
TRACK CIRCUIT POWER SUPPLY consists of three separate transformers, three fixed resistance units and a power transfer relay. Overall size 11¾ x 12 x 5¾, weight 20 lbs.

RACO TCTU-1
TRACK CIRCUIT TRANSFER UNIT consists of a power transfer relay, two half wave rectifiers and an adjustable resistance unit. Overall size 7 x 7¼ x 5, weight 4 lbs.

TYPICAL APPLICATION



*ATR, BTR, AND CTR CONNECTED IN USUAL MANNER FOR AC-DC TRACK CIRCUITS

Contact the RACO office nearest you for complete details.

Railroad Accessories Corporation

Main Office and Plant: 4650 MAIN STREET N.E., MINNEAPOLIS, MINN. 55421
Office and Plant: 7615 NATIONAL TURNPIKE, FAIRDALE, KY. 40118

IN CANADA: Vale Enterprises, Ltd., 1120 Claire Crescent, Lachine, Quebec

Circle 1 on reader service card on page 38

JULY, 1968

Railway Signaling & Communications

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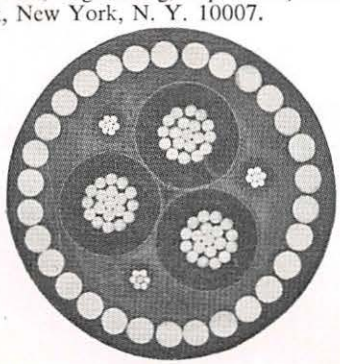

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Simmons-Boardman **TIME-SAVER** Publication

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FOR AC-DC TRACK CIRCUITS

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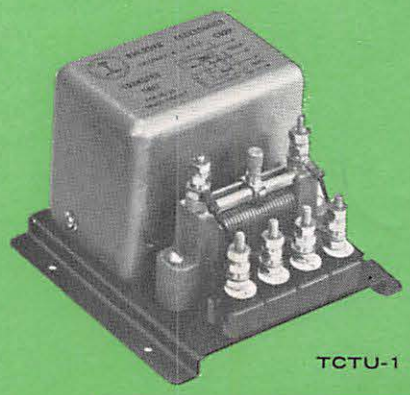

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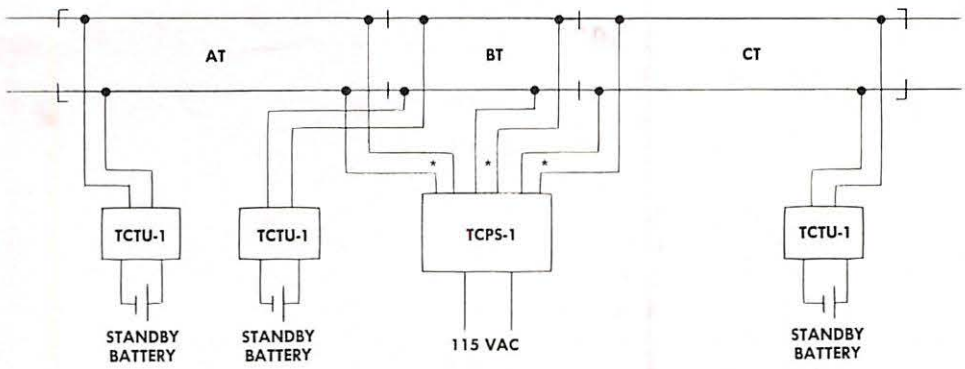

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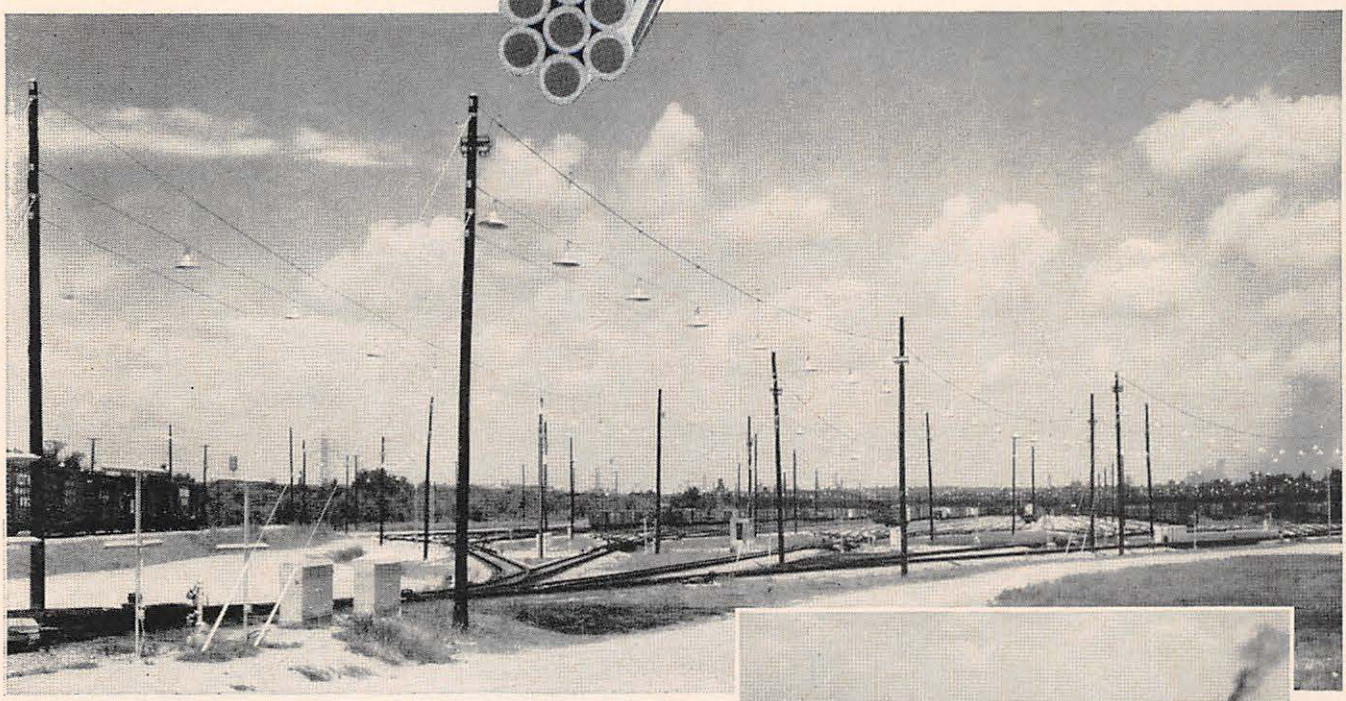
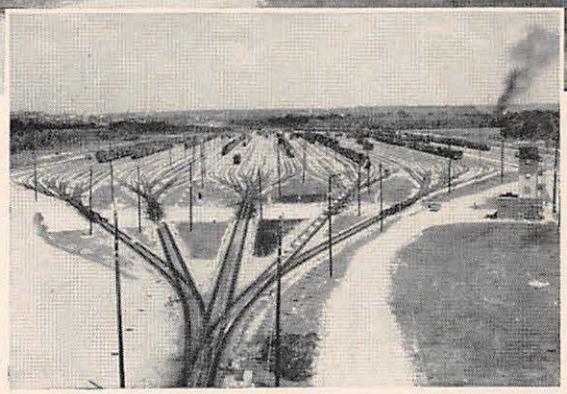
Circle 1 on reader service card on page 38

The Alumoweld® Strand Supporting These Catenary System Lights Will Never Be Weakened By Corrosion





Southern Railway System's new marshalling yard at Macon, Georgia.

Alumoweld strand is designed to stand the test of time

Southern Railway System will never have to replace the guy and messenger strand on the catenary system supporting the hundreds of overhead lights in its new marshalling yard at Macon, Georgia. That's because the strength of Alumoweld® strand is permanent. The thick aluminum cladding—guaranteed to be no less than 10% of the radius of each wire—prevents corrosion of the steel core.

On any overhead line or catenary installation, strand is a small part of the total cost—unless it must be replaced. To protect your investment in such installations, use Alumoweld—the strand designed to stand the test of time. Write today for Engineering Bulletin E. D. 3000.

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COPPERWELD STEEL COMPANY

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strand

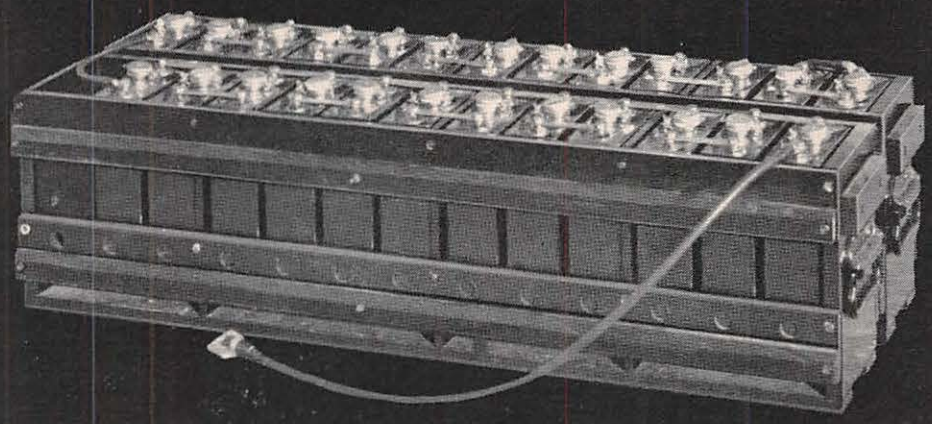
...for ***supporting cables***

...for ***guying towers and poles***

Circle 4 on reader service card on page 38

The battery and ½

The nickel-iron battery rides again.



(and again, and again, and again, and again.)

New rapid transit systems are installing the Exide nickel-iron battery. Because the pioneer systems get so much dependable life out of it. Time and time again.

The nickel-iron battery is the longest-lived battery around because it's all steel. Everything from the tubes in the positive plate to the steel casing. And the electrolyte solution's not only noncorrosive, it's really a steel preservative.

That's why it can take temperature extremes—even to leaving it out all winter. And take things like accidental shorting, overdischarging, even reverse charging.

And that's why we call the nickel-iron battery a "battery and ½." To learn more, write Industrial Group, ESB Incorporated, Box 5723, Phila., Pa. 19120.

World leader in packaged power.

ESB Exide®

July 1968
Vol. 61 No. 7

Railway Signaling & Communications

C&S Men Discuss Ways to Meet New Technology 13
Railway Cybernetics: Japanese Test Leaky Waveguide 24
Feedback: Microwave and Rain 26
Data Sheets 151 & 152: Data Modems 28, 30
News Briefs 32
Product News 34
View from the Crossarm 36

Editorial Office, 14 E. Jackson Blvd., Chicago, Ill. 60604

Robert W. McKnight — Editor
Elsworth L. Abbott — Associate Editor
Grace Rempert — Editorial Assistant

Executive Office: 30 Church St., New York, N.Y. 10007: Robert G. Lewis, Publisher; Fred B. Hecht, Production Manager; John E. Rogers, Director of Circulation; Joel Petrower, Art Editor; George Lubalin, Managing Art Director.
Advertising Sales Department: C. James Fisher, Vice-President—Sales, 14 East Jackson Blvd., Chicago, Ill. 60604; Constance Nicolai, Manager of Contracts, 30 Church Street, New York, N.Y. 10007.
NEW YORK, N.Y., 10007, 30 Church St., Phone: 212-964-3060. W. Arthur Cubbage, Regional Sales Manager; Charles E. Keil, District Manager.
CHICAGO, ILL., 60604, 14 E. Jackson Blvd., Phone: 312-427-3501. C. James Fisher, Vice President-Sales; Kerry F. Sheeran, Regional Vice President; John M. Brennan, Regional Sales Manager, William J. Lyneis, Ross Mandic, District Managers.
PITTSBURGH, PA., 15219, 720 Frick Building, 437 Grant St., Phone: 412-471-7871. Ronald M. Giallonardo, Regional Sales Manager.
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DALLAS, TEX., 75219, 3636 Cedar Springs, Phone: 214-521-2322. Joseph Sanders.
LOS ANGELES, CAL., 90017, 1313 W. Eighth St., Phone: 213-483-8414. Fred Klaner, Jr., The Klaner Co.
SAN FRANCISCO, CAL., 94133, 515 Pacific Ave., Phone: 415-421-7004. Lewis A. Vogler, Lewis A. Vogler & Co.
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Editor's Corner

It isn't often that we give someone a pat on the back for a job well done. However, we offer our highest accolades to George McCann, Secretary of the Communication & Signal Section, AAR.

Reasons for these kind words are twofold: (1) we think that people should receive flowers while they are alive, not after they are dead; and (2) we feel that we should pay tribute to one who has truly performed a fine service not only for railway communications and signaling men, but to suppliers as well. We say these things, not because George has always been pleasant and agrees with us, but because of recognition of his sometimes difficult role of being a mediator or buffer between ourselves and our readers. Also, in all fairness, we should point out that George has often been quite critical of our editorial policies and operations. Since we strongly believe in free speech and free interplay of ideas, we accept and respect his thoughts and comments, whether they be critical or complimentary.

The tonnage of fine publications issued by the C&S secretary's office is due to George's leadership, plus his long hours of toil in handling the myriad of details associated with publication and association work.

Obviously he does not work alone, but with an equally hardworking and devoted staff. But leadership can mean the difference between success, a mediocre job or failure. In this case, it means success.

We salute you, George McCann, as the C&S man of the month, yes even of this year and many years to come.

Bob McKnight

P.S. Although he may be mercurial in temperament, George can always see the sunny side of life, and bring a hearty chuckle to us all with his ready wit.

$80.00 a quart.

$80.00 a quart is no exaggeration. By the time maintenance crews add water to all your communications battery installations, you could pay that much . . . or more.

Cutting down on the number of times you have to add water is part of the solution. With C & D lead calcium batteries you make water additions only once every three years, or so. Conventional antimony types need water 6 to 12 times a year.

Eliminating equalizing charges is another big factor. C & D lead calcium batteries never need one if kept on the proper float charge. Antimony batteries average one equalizing charge a month, or they require a check charge at least 6 times a year. There is never a need for an equalizing or check charge with a C & D lead calcium battery.

Now, will you install C & D lead calcium batteries and make up to 12 times fewer maintenance calls.

If you can't spare $80.00 for a quart of water, spare a few minutes to get the maintenance-saving facts on your communications battery installations. Write C & D Batteries, Conshohocken, Pa. 19428.

C&D BATTERIES

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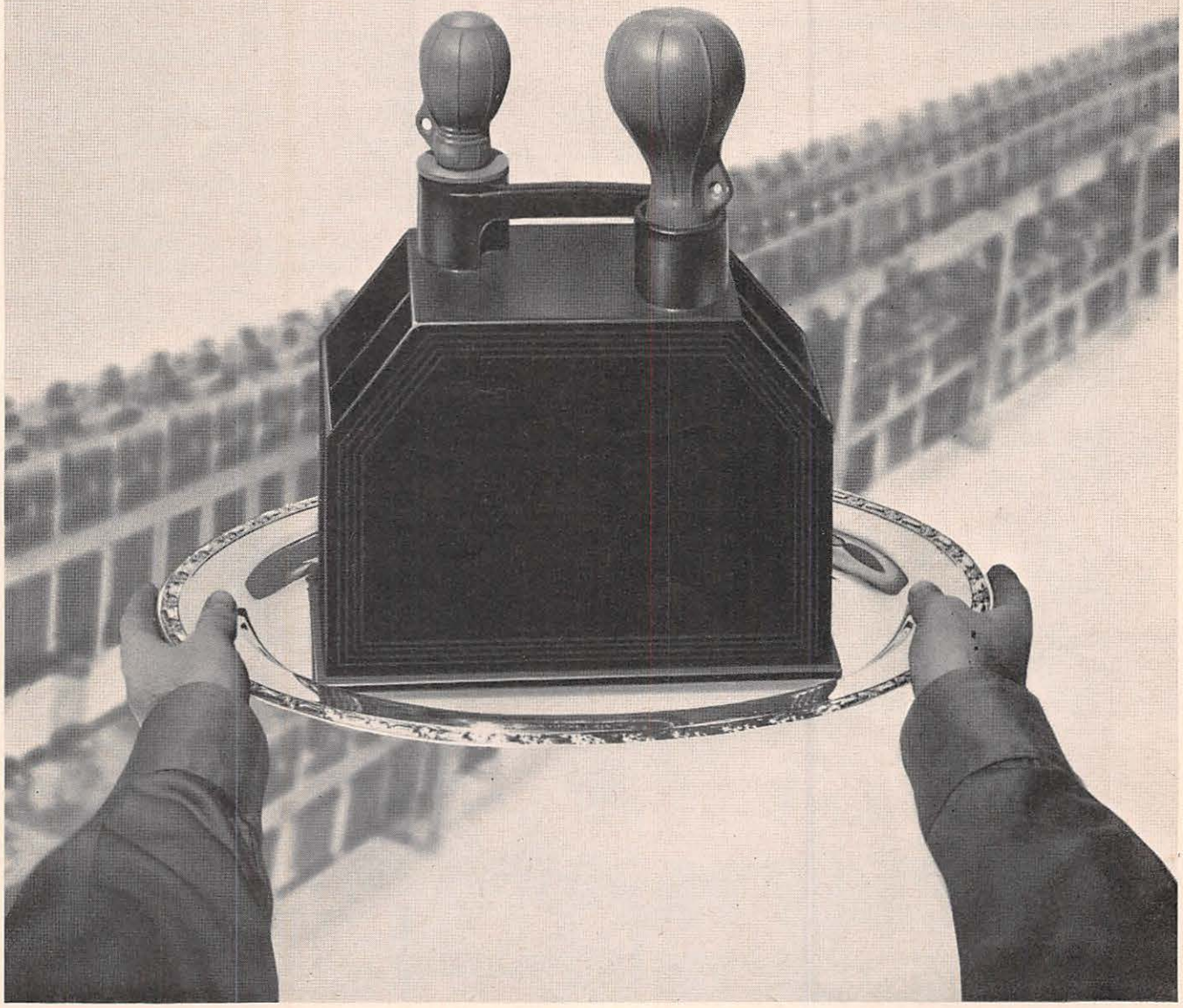

Circle 6 on reader service card on page 38

from Marquardt Industrial Products...

THE NEW PULSE MODULATED TRACK CIRCUIT

MIPCO INTRODUCES the Pulse Modulated Track Circuit, a new solid state audio frequency system now available in configurations which operate compatibly *with A.C. or D.C. electric propulsion currents, D.C. coded track circuits, A.C. signal circuits, and coded cab signals.* This latest MIPCO addition to a broad line of electronic grade crossing and signal control systems operates on a unique pulse modulation technique which overcomes external interference problems characteristic of conventional tone devices. Requirements for insulated joints and impedance bonds are minimized or eliminated entirely, depending upon specific applications.

FEATURES OF THE MIPCO PULSE MODULATED TRACK CIRCUIT

- Eliminates most insulated joints and impedance bonds!
- Up to 11 operating frequencies with selective pulse modulation rates!
- Increased power output; low power drain!
- Maximum operational security through a digital code modulation system!
- Reliable fail-safe operation under extreme environmental conditions!

Ask your MIPCO representative about the PMTC family of products and the complete line of electronic track circuits and grade crossing protection systems designed for your specific applications.

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TO SERVE
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MIPCO offers an expanding product line and diversified services to meet the continuing demand for modernization by the railroad industry. Call upon MIPCO for new systems and components for improved, efficient service at lower operational and maintenance costs.

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RAILWAY PROGRESS INSTITUTE

MARQUARDT INDUSTRIAL PRODUCTS CO.

Circle 7 on reader service card on page 38

At one time it would have cost too much to link this small railway station to the line's main microwave system. But not any more—thanks to the 71F by Lenkurt.

Lenkurt's 71F is a 1 to 300-channel 2 GHz microwave radio system designed specifically to provide economical low density "feeder" routes from communications main lines to remote railway stations and control centers.

Its 2-Watt output improves path reliability at the same time as it decreases antenna size and tower loading. The radio cabinet and all plug-in units are r-f shielded to eliminate VHF interference. And its modular construction means easy maintenance and few spare parts. What could be more important when your 71F is miles from the nearest technician?

For more information about the economical 71F, call or write Lenkurt Electric Co., Inc., San Carlos, California.

LENKURT ELECTRIC
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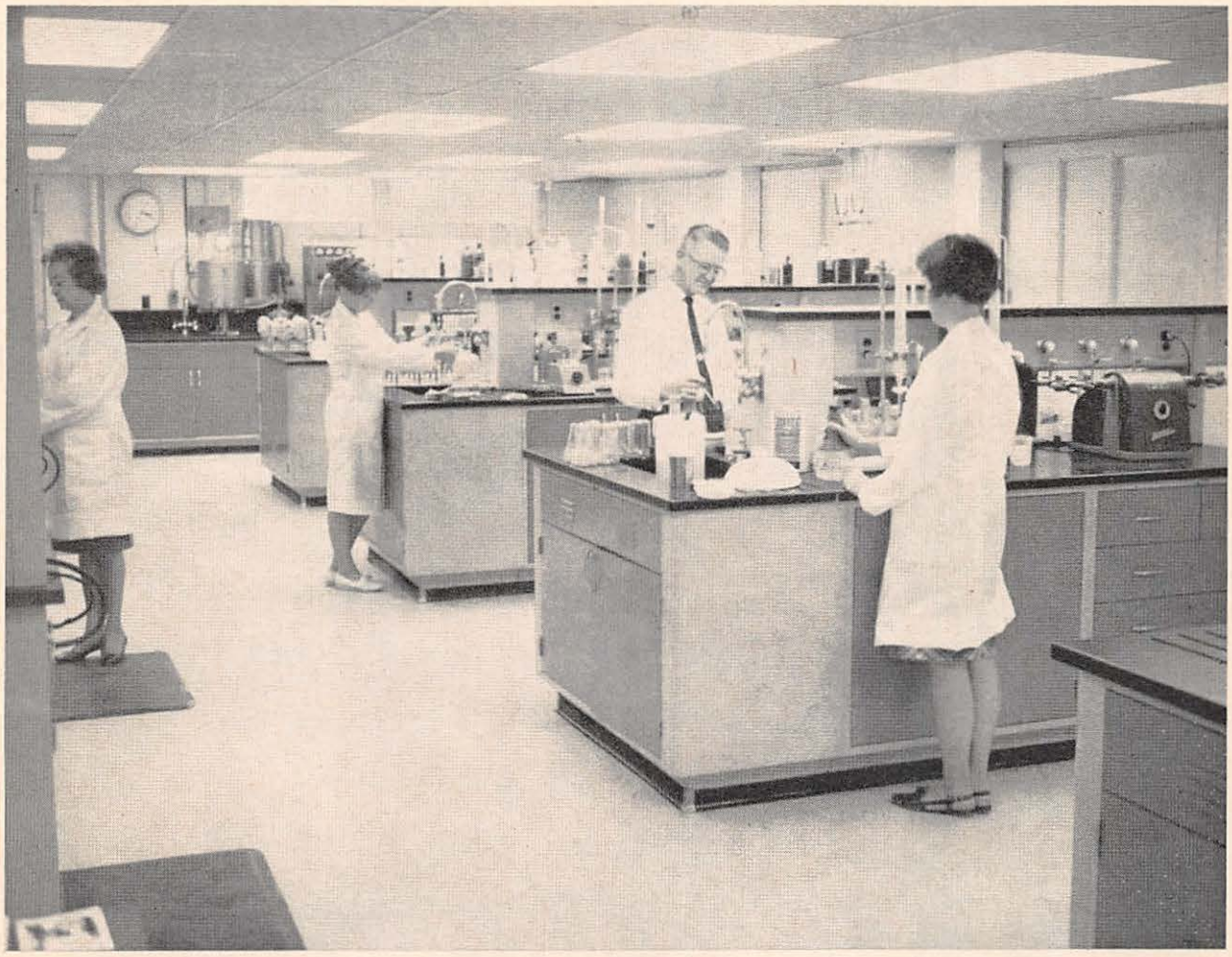
Circle 8 on reader service card on page 38



We make signal and control systems

. . . so why should we have a chem lab?

Because we're very fussy.

Suppose you bought a GRS item with poor paint, or with peeling plating.

Sure, we'd repaint it, replate it, or replace it . . . and we'd lose money on it—and maybe lose a friend too.

We hate to lose money—or friends either. So we make it just as good as possible the first time—with materials that meet specs and with inspection that really inspects.

This lab is just a part of the investment we have in GRS quality insurance—for you.

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3440

Circle 9 on reader service card on page 38

Introducing the HH-300 Du Mont's FM hand-held two-way radio

On board, in the yard, or along the right of way, no portable, two-way radio exceeds Du Mont's HH-300 in reliability and performance, wherever lightweight communications equipment for direct voice contact with stations, mobile units or other portable transceivers is required. The Du Mont HH-300 "Railroad Series" hand-held FM radio weighs only 30 ounces, is completely solid state, doesn't mind water or snow and is reliably rugged. It operates in the VHF range of 132-174 MHz with a power output of more than 2 watts. Simplified circuitry consists of 14 replaceable plug-in modules, allowing fast, easy service by any maintenance organization. Optional accessories include five channel operation, continuous tone squelch, railroad chest harness, rechargeable nickel cadmium battery and an exclusive new Du Mont development in a mercury battery pack utilizing low cost replaceable cells. Sound like something your line needs right now? For more information, use the coupon below. Or call Du Mont at (714) 776-6760.

DU MONT®
MOBILE COMMUNICATIONS DIVISION

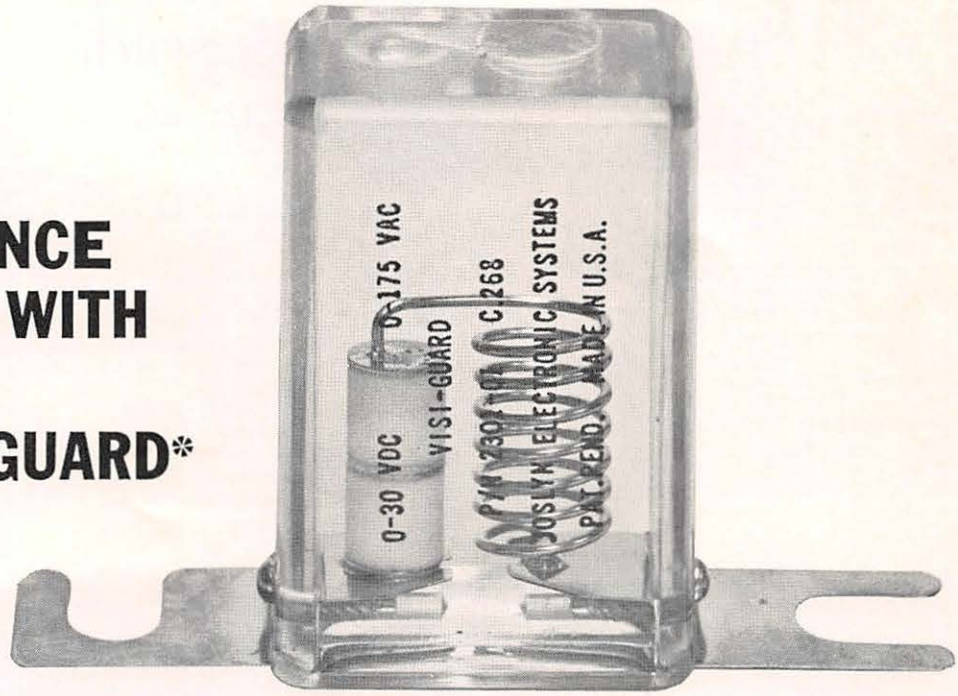
A DIVISION OF LING ALTEC, INC.
1515 So. Manchester Ave., Anaheim, California 92803

DU MONT MOBILE COMMUNICATIONS DIVISION
1515 SOUTH MANCHESTER AVENUE, ANAHEIM, CALIF. 92803
Your HH-300 "Railroad Series" two-way radio sounds mighty interesting. Let's communicate.

NAME_____
FIRM_____
ADDRESS_____
CITY_____ STATE_____ ZIP_____

Circle 10 on reader service card on page 38

NOW– ONE LESS MAINTENANCE PROBLEM WITH JOSLYN'S NEW VISI-GUARD*



How much time and money, maintenance-wise, do false restrictive failures due to transients in the electronics cost you? Chances are, plenty! Worse yet, the problem they cause for you is compounded when you factor in the cost of disrupted schedules.

Now you can virtually eliminate those damaging transients up to 50 times or more every time they hit your electronics! Joslyn's new lightning and electrical signal type surge arrester — the 2300 series VISI-GUARD — protects your signaling equipment against larger surges and more often than any other means you presently may be using.

Breakdown voltage – 500 v peak. Response time as fast as 0.15μs at 10 kv per μs rate-of-rise. A minimum of 50 rated operations each consisting of a 5,000 ampere discharge current (10 x 20μs waveshape) and resulting power-follow current which automatically extinguishes. Another plus feature: extreme duty discharge capacity of 15,000 amperes 10 x 20μs waveshape.

The Josyln VISI-GUARD is dimensionally designed to directly replace existing arresters using any base including the molded plastic base, or AAR porcelain base, or the three-post porcelain base.

The price for protection has to be considered, of course. But if a device doesn't work, why buy it? With VISI-GUARD you know it will work. For that assurance, $8.60 each in quantities of 100 to 299 is low. VISI-GUARD — the device that frees maintainers for other problems. Another quality product in Joslyn's full line of electronic surge protection equipment for electronic systems. Write today for new JES 140 brochure. Joslyn Electronic Systems, Santa Barbara Research Park, P.O. Box 817, Goleta, Calif. 93017. Tel. (805) 968-3551.

Data subject to change without notice. Prices f.o.b. factory. *Pat. Pend.
Complete specs available in VSMF, Visual Search Microfilm File

JOSLYN
ELECTRONIC SYSTEMS

052

Circle 11 on reader service card on page 38

The Stromberg-Carlson Man-on-the-Scene will help you switch to a better switch

It's the XY® Universal Switch, the heart of the Stromberg-Carlson telephone switching system. Universal because the same XY switch is used interchangeably to perform all of the major switching functions: finding, selecting, and connecting. The universal application of this switch assures high reliability, high efficiency, low maintenance, and economy of the XY Dial System. These systems can be designed and engineered specifically for your operations by people who fully understand your needs.

TYPE H-RR: Engineered to your needs. Unlimited capacity. It provides fully flexible ringing, single-party and/or multiparty. Loop and/or E & M trunk-connected. Attendant's cabinet available for any model. And the system is fully compatible with your present communications network.

TYPE F-80A-RR: a low-cost, hard-working packaged system that comes ready to install and go to work for you immediately. Its capacity is 80 lines, 14 trunks. Loop and/or E & M trunk-connected. Provides single-party ringing, 48-volt operation, 1200-ohm station loop. Acoustically treated equipment cabinet available. Works with your present communications setup.

S-C 500 TELEPHONES: rugged, reliable, versatile. Available in standard desk and wall models. Plus two-line desk and wall types and two-line desk and wall models with Hold on each line. In several colors.

1700-3 TELEPHONE: three-line self-contained desk model. No external fixtures required.

The Stromberg-Carlson Man-on-the-Scene is your source for more than equipment. He brings you complete customer services, from systems planning to financing. When you want to talk railroad communications with him, contact Railroad Division, Stromberg-Carlson, 100 Carlson Road, Rochester, N.Y. 14603. 716-482-2200.

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A Subsidiary of General Dynamics

Railway
Signaling &
Communications

AAR C&S

Sectional Meetings

How C&S men can meet today's centralization

The trend towards centralization of all management and operating functions has placed a heavy burden squarely in the laps of signal and communications officers. The two sectional meetings, eastern and western, of the AAR C&S Section clearly reflect concern and respect as top S&C personnel square off to solve those problems created by the new technology.

Long range possibilities, in terms of economics and improved service to railroad customers, appears to be indisputable so far as the implementation of automatic car identification is concerned, but, how it can best be utilized for optimum benefits is still a question.

ACI will be a big project and how work associated with it can be properly assimilated into an already saturated department is creating some questions. Obviously the skill level has been elevated in step with the technical requirements of the equipment and S&C men are concerned with the problems of hiring and training employees *(RS&C May 1968 pages 17-23)*.

In effect the two sectional meetings classified the vital areas of future concern into four distinct categories:

- Implementation of automatic car identification
- Hiring and training employees
- Protection and the reliability of equipment
- Safety at railroad-highway grade crossings

C&S Role Today

By R. C. Grayson
Vice-President Operations
St. Louis-San Francisco

You, as well as the other departments, should know that your work is not an end in itself but a means to an end. For instance, the C&S department might well consider the other departments of the railroad; engineering, mechanical, transportation, traffic, etc., as their customers, and direct your energies to solving or helping to solve their problems. Make yourselves as indispensable to them as you can. Other departments are not as aware as you are of the benefits you can provide. Interest yourselves and become familiar with all phases of your company. In the areas where your expert knowledge and ability are useful, convince your customers that you can help them with practical solutions. The day is gone, if it ever existed, when any department can isolate itself, and attend only to its own problems as if they were an end in themselves.

In seeking solutions to our problems, your part has traditionally been directed to technical problems. You have done remarkably well. The systems you have devised have contributed greatly to the success the industry has achieved today. However, keep in mind this fact in your work. It is probably true that any technical problem can be solved if sufficient funds are available. In our industry, unfortunately, we do not have unlimited funds. Therefore, we must resort to ingenuity and innovation, to find practical and effective solutions within the bounds of our economic resources.

In your work, consider this point, also. We have traditionally designed and installed equipment to operate as maintenance free as possible for 50 years or longer. These systems represent costly investments in installation expenses. With the rapid advances in technology today, we should take another look at our installations to make sure we are not spending excessively on installation costs on a system that could well become obsolete at half

its life. If no unreasonable penalties are attached to maintenance and amortization costs, it seems preferable to install signals or communications with an estimated life of 10 or 15 years rather than 25 or 50 if the initial cost can be substantially reduced. As fast as we are moving today, I doubt if anyone can forsee what will be required more than 10 or 15 years from now.

An area where your background and ability gives you a unique advantage in overcoming problems is in the congested areas of major terminals. We often have facilities of two or more railroads side by side and make an inefficient use of the total plant. For instance, we have main tracks of different railroads adjacent to each other, and at a particular time one road may be completely blocked and overloaded, the other might be unused. By pooling or consolidating selected facilities, we can obtain the flexibility to improve all the roads' operation and quite likely do it with increased efficiency in maintenance. In order to operate properly, such systems will need good signals and communications to obtain the maximum benefit. You people here are probably in the best position to recognize, design, and propose systems to allow us to take advantage of these situations.

You have made remarkable advances in railway signaling in the last 30 years. Most of the effort, however, has been devoted to high density of traffic lines. This has provided us greater safety, higher speeds, reliability and efficiency of operation. These systems are good, but we need further improvement. Automatic or semi-automatic signal systems are proving more and more desirable. You need to investigate with your computer people the feasibility of computer controlled CTC. Also, we have many secondary or light traffic routes where the expense of traditional signaling has not been justified. Have you truly exhausted all possibilities for a light route CTC system within the bounds of the economic resources that can be allocated for such a use?

On the communications side, our use of computers has made possible information tools unknown and not even thought of 10 or 15 years ago. Our experience points out that we cannot take advantage of this new tool unless we have a good communication network to input and output information from all over our systems. Data handling throws a new kind of load on our circuits. The quality must be better. We have a new set of rules and requirements and transmission must be exact. So that we may have accurate and timely information to manage our business, you must accept the challenge and see that your communication

Characteristics for automatic identification

- **The transmissions should be automatic**—There should be no conscious effort on the part of the operator to start or stop the automatic means of identification and the identifying means should automatically come on the air each time the station is put on the air.

- **Identification should be by international Morse telegraph at about 25 wpm**—Identification by slow speed Morse code makes possible simultaneous transmission of message by voice and an identification. Telegraph transmissions are known worldwide and readable by many people. No modification to call letter assignment procedures would be necessary.

- **The transmissions should be simultaneous**—By making the transmission simultaneous no extra air time is required and the field organization should be able to recover the call or part of the call from one or a number of transmissions. We believe it is not necessary for each transmission to have an entire call sent nor to start from the beginning of each transmission.

- **Identification should be continuous**—Automatic means of identification should be transmitted continuously while a station is on the air regardless of the length of transmission. Since a call either by code at 25 wpm or voice requires in the vicinity of three seconds, full or partial transmissions will be valuable to the field. In cases of intermittent interference or signal fading conditions continuous transmission of calls with complete calls in as short a time as possible create the most favorable conditions for enforcement.

- **Tones for identification should be fed with the voice audio into the transmitter**—By approaching the problem from the point of view of integrating the identification in the audio we create a situation whereby a minimum of modification is needed in transmitters or receivers, as contrasted with methods involving transmission of identifications by other types of modulation in the primary transmission.

- **The tones used for identification should be standardized for apparatus simplification in the monitoring organization**—By standardizing the tones to one, or a small number, it is possible for all field offices to have filters for these specific tones to recover the call from a complex transmission. A family of tones should be selected to serve the purpose. The number of tones used should be kept at a minimum for apparatus simplification at FCC, but it is evident that it would probably not be possible to obtain a single universal tone adaptable to all services because of the differing audio band pass characteristics used.

  Since, in many cases, the field now tape records transmissions containing violations, the violation and the identification would be simultaneously stored and the identification could be recovered by the use of an audio filter passing the identification tone frequency.

- **The receivers used should be fitted with a filter to remove the identifying tone**—Experience in the aviation field has shown that it is entirely possible to use a tone at a relatively high level within the voice band pass of the ordinary audio band and totally remove it in the receiver by means of a low price filter. This is possible in a system where

system meets these new requirements.

Hump yards that you have installed and are responsible for have given us great improvement in efficient yard operation. However, it is safe to say that a yard installed 10 years ago does not meet our requirements of today unless it has been extensively upgraded. Longer, heavier cars carrying more expensive lading have imposed more requirements on this equipment. Acceptable solutions here will tax your imagination and ingenuity to the utmost, but to satisfy your customers, those who make use of your developments, you will be called on to improve facilities.

Identification of RR radio is a problem

By Curtis B. Plummer
Chief, Field Engineering Bureau
Federal Communications Commission

It appears that you in the railroad radio service create a problem for us in the FCC—first, you desire a minimum of identification and to us a very vague identification. On the other hand, when you are receiving interference you demand fast action in removing the interference.

Organized specific identification of each transmitter is our greatest aid and time-saver in locating interfering radio signals.

Identification requirements in the railroad radio service states in part: "stations in the railroad radio service may be identified, in lieu of the use of assigned call letters, by the name of the railroad; or, if that is not practicable, by such other number or name as may be specified by the railroad concerned for the use of employees of the railroad to identify the fixed point or mobile unit."

The wording in this rule makes it difficult for FCC monitoring observers to obtain identification of either base stations or mobile units in the railroad radio service. It is easy to forget to send the call identification in many of the intermittent services.

If FCC must find a radio station by the use of direction finding and signal strength measurements, the cost is many times that of identifying and locating a station by means of call letters. Direction finding above 30 mHz because of reflections is not as easy to use as compared with direction finding below 30 mHz. Likewise in using a rather large number of short transmissions, identification of every transmission or an appreciable number of transmissions uses up considerable air time as the usual identification takes three or four seconds.

It appears that automatic identification of radio stations should be thoroughly investigated for use in various radio services for the purpose of saving air time and making it easier for the FCC field organization to identify stations.

in railroad radio service

the licensee controls both the transmitter and receiver, i.e., Citizens Band and Land Mobile. It would be more difficult in the Marine and Aviation services as there may be international problems involved. To apply a tone to Broadcast stations it is difficult to have the relatively large number of receivers in the hands of the public modified. Identification in Broadcast must be "hidden" from regular receivers, indicating a tone below 25 Hz would be necessary. Land mobile systems using tone controlled squelch already have cut off below 300 Hz in the audio system. Use of a tone below 300 Hz for automatic identification would not require the addition of filter in receivers.

- **Complex transmissions and secrecy devices**—The use of complex transmissions involving both voice and written material is increasing. Inherently the use of these systems imposes an almost impossible apparatus problem for the field engineering bureau as there are a very large number of systems of complex transmissions used for the purpose of economy of spectrum, equipment savings and secrecy. For a considerable period of time, multiplex teletypes have been used by the international and domestic point to point stations. Also, these are combined with voice and data transmissions. A growing desire for voice secrecy devices and complex transmissions has required an FCC policy of allowing the use of these devices for a considerable period of years but only with plain language identification.

The international work that has been done over the last 10 or 12 years on the subject of automatic identification has been largely concentrated on the subject of achieving some universal means of identification, preferably automatic, that would not require the enforcement agencies of the various governments of the world to purchase infinite varieties of apparatus to handle complex transmissions. We already have in effect certain special authorizations in international point-to-point service to allow simultaneous identification of complex transmissions by some method of superimposing international Morse telegraph code at 25 wpm.

It has been noted that on certain scrambling devices used on phone transmissions, the secrecy methods are not necessarily stable but change from day to day. This basic principle of cryptography is logically applied to voice scrambling secrecy devices. This makes the monitoring problem even more difficult and points in the direction of an identification independent of the secrecy system.

It appears that some standardized method of automatic identification for the enforcement administration of multiplex transmissions and would allow further freedom in the use of secrecy devices.

- **Choice of tone**—In choosing a tone to be keyed for automatic identification of a station, consideration should be given to a single universal tone within the voice bandwidth that has the minimum of conflict with existing tones used in the various services. A single tone would be the most desirable, however, the use of two, three or even four tones would not be unreasonable. If every organization were to choose their own tone, tunable audio filters would be necessary.

If monitoring enforcement in the railroad radio service is to provide any useful result, there must be a change in the rules which will permit FCC monitoring personnel to identify by call sign each station in this service.

S&C lines need surge protection

By J. E. Moe—Director
Engineering & Development
Railroad Accessories Corp.

What causes surges? The first and most obvious is a lightning discharge. Even with a discharge some distance from railroad lines or track a substantial surge voltage can develop on and across the conductors coming into an instrument case. This is due to the relatively high resistance of the earth when compared to the current flowing in a lightning discharge, and that a voltage drop in conductors works here too. In short, the earth is not really a "ground" at all. Open wire lines and tracks, may represent a potential at some other spot which is very different from that where the equipment is located.

A second source of surges is man made. We use a power distribution network which is always in close proximity to structures. Signal equipment is coupled inductively to this network and also directly through power drops. This system is thoroughly protected against lightning, but faithfully delivers both switching and fault surges to the equipment along with the power.

A third source of surges is perhaps the most difficult to protect against. When a charged cloud is above a suspended conductor it will create an electrical field varying approximately linearly from the ground, which we will call zero potential, to the cloud. The pole line extends into this field. The ionizing voltage of air and thus the maxiumum voltage gradient which can exist before a lightning discharge occurs is 3,000 kv per yard. With the line 4 to 10 yards high, 30,000 kv, relative to ground can exist without any sign of lightning. These charges may build up very gradually due to a charged cloud slowly approaching. This is in distinct contrast to the sharply rising wave front of a lightning discharge or man-made surge.

Air gap arresters have been used to provide a discharge path. Present-day, gap-type devices are available with a very consistent breakdown voltage in the range of 700-1,000 volts and are virtually completely self-clearing in the event of a discharge.

As the practical low limit of an air-gap device is about 500 volts, a bleeder-type device, or equalizer, was developed to give a breakdown in the range of 75-150 volts and a small shunt resistance to equalize potential. These are usually made with a semi-conductive material, silicon carbide, which exhibits a high resistance with a low voltage impressed across it, but a lower resistance as the voltage increases.

Satisfactory as these devices are in limiting surge currents and damaging potentials in conventional relay equipment, they have not done the job with solid state equipment. Two basic reasons for this are: the semi-conductor is a low impedance device and it is fast. Conventional relay equipment has been ruggedized so as to have rather large masses of material to dissipate sudden energy inputs. With vacuum tubes we can increase impedances to limit current to reasonable limits even with relatively high surges.

Neither of these is practical with a semi-conductor and the transistor in particular. A transistor is a current-amplifying device and the introduction of impedance to limit surge current flowing in the circuit would also seriously reduce the efficiency of the circuit. Also, the thermal mass of the junction is low and unable to dissipate large instantaneous bursts of energy due to surge currents.

In addition, a semi-conductor device is easily damaged by a breakdown in the reverse direction. If a junction in a semi-conductor is "punched through" by a voltage exceeding the peak inverse voltage for that device it will fuse in the area of the junction that has broken down. As this area is often only a small fraction of the total area of the junction the heat dissipating ability is likewise reduced. Thus, a junction may be destroyed by fusing a small area even though 99+% of the junction is still intact. Fortunately, silicon diodes and some other classes of semi-conductors can be constructed to avoid this problem. These are called avalanche breakdown devices and in these, the entire junction breaks down at once to give a much greater energy dissipating ability.

Certain classes of semi-conductors are less prone to surge problems. Selenium diodes (rectifiers) are excellent in this respect. The junction covers a large area and if it does break down, it burns out and vaporizes so is "self healing". Silicon devices are next best, followed by germanium devices as the poorest.

There are two reasons why conventional gap-type arresters and equalizers are not capable of doing the job. The first is that they just aren't fast enough. The voltage shows a sharply rising wave front due to some external surge. As the voltage rises to and above the breakdown voltage of the arrester, it will ionize the air in the gap.

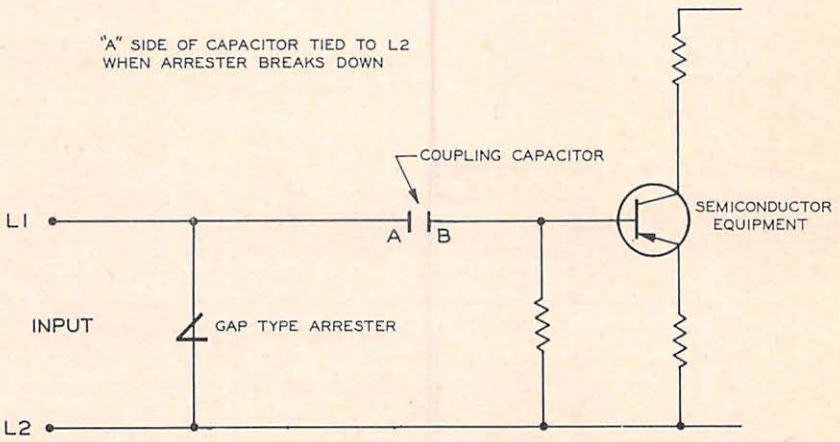


Figure 1—Charge capacitor to arrester breakdown voltage.

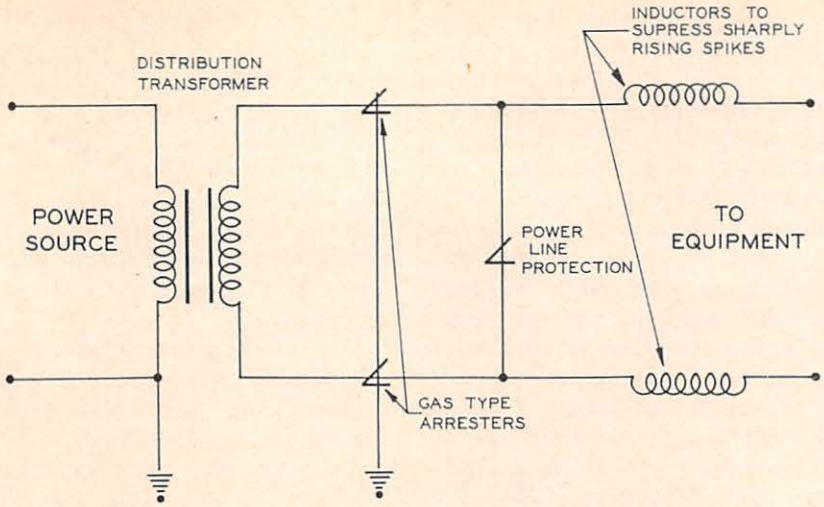


Figure 2—Protection on 115 or 230-volt AC power lines.

However, before it does ionize sufficiently to discharge there can be a pulse of several μsec (microseconds) duration of a voltage many times that of the breakdown of the arrester. This surge will often cause semi-conductor failures. The same "slow" operation of the equalizer causes a similar problem.

The second reason is that the inherent breakdown voltage of a reasonable air gap is too high. With much of the equipment operating at 0 db (0.78 volts on a 600-ohm line) a surge of 500-600 volts is often a damaging voltage although there is no arrester breakdown. Going back to the example of a cloud creating a charge on the line, we see that a voltage can slowly build up to the point where the arrester will break down. If our equipment contains an input coupling capacitor we will charge this to the arrester breakdown voltage and then discharge it into the equipment when the arrester breaks down (in the reverse direction), figure 1. We cannot use a bleeder type or equalizer on line circuits although the breakdown voltage is much more favorable.

An investigation into possible ways to overcome these surge problems leads to the application of solid state equipment to protect solid state equipment.

Protection problems can be grouped into three general areas.

- AC power lines
- Battery power supplies
- Information circuits of AC or modulated DC

The approach taken on each of these is quite different.

For 115 or 230-volt AC power lines a bleeder-gap type arrester or modified equalizer can be used. In this case, we are always working into a transformer and consequently have a relatively large stray inductance and capacitance to suppress the initial spike coming through the arrester. In addition, a small inductance can be added in the lines to suppress this spike so it will not capacitively couple inside the equipment, figure 2. With this protection, damage can almost be eliminated.

A lead acid battery has been said to be one of the best means of suppressing surges. There is a low internal impedance, usually in the range of a few hundredths of an ohm which is, of course, across the input to the solid state device being powered.

Unfortunately, this cannot be utilized to full advantage due to inductance and resistance in the supply lines. The battery is often located remotely requiring several feet of battery cable. It is possible for surges to couple into this system and appear at the terminals of the solid state equipment. It is always preferable to wire from the rectifier to the battery and then in separate cable, physically separated, to the equipment.

Battery supplies are not directly wired out on pole lines and we are seldom confronted with the slowly rising voltage due to the voltage gradient from a cloud; we can expect only surges with rather steep wave fronts. The use of a capacitor can attenuate these high frequency components. Typical capacitances are on the order of 100 to 20,000 microfarad.

In addition to the shunt capacitance it is necessary to provide a means of clipping transients. This is either done with a zener diode pair, an avalanche breakdown device, or a "back-to-back" selenium pair which breaks down in the reverse direction.

Because of the high currents in these surges, it is practical to use an inductance in the lines to limit the peak value to a level which will not affect the surge protective components. The final form of this protection is shown in figure 3.

As further protection a bleeder-type, low-voltage breakdown arrester or equalizer on the battery side should be added to handle all surges up to the point of destroying the equalizer, providing the protector is designed to suppress what is "left over" from the equalizer.

Surges in battery supplies may also be snubbed by using a silicon controlled rectifier. Unfortunately when an SCR is triggered it stays on as long as current continues to flow. Consequently, when there is a direct current application, a circuit breaker or other means to interrupt the current and release the SCR must be

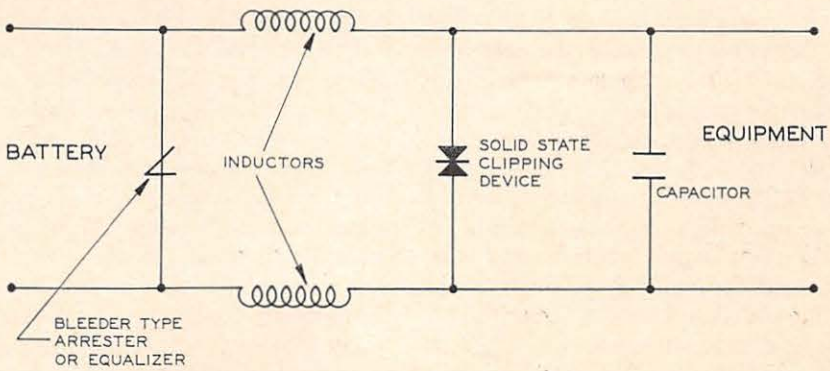


Figure 3—Protection where a battery is located.

provided. This results in a larger more expensive package.

In the case of information circuits, we are concerned with the third family of protection equipment. "Information circuits" represent all circuits, whether track or line, which convey information by means of modulation of DC or by AC which may be modulated, pulsed or convey information by its presence. We are almost always dealing with higher impedances than that associated with AC power lines, or with low-voltage, low-impedance track circuits.

The problem here is considerably greater. Unlike the power line, there is little or no "damping" within the equipment in the form of large transformers, leakage reactance, stray shunt capacitance, etc. Unlike the DC power supply we cannot use a large shunt capacitance or we would severely attenuate the information. A gap-type arrester must be used to avoid loading the line, except in the case of track circuits.

There are two basic approaches. One uses clippers and ladder attenuators. Zener diodes or similar clipping devices can be used, but sufficient impedance must be introduced in the line to limit surge currents to a level the zeners will tolerate. The addition of this impedance will, of course, introduce an attenuation of the information matter.

The second approach is by means of an SCR-type shunting device. This has the advantage of being almost a zero resistance when it is triggered. It is not necessary to add inductance to the lines as the allowable currents are higher. In the case of the clipping device the clip voltage level still appears across the device during a surge. The voltage-current product, or dissipated power, is much greater than the case of the SCR where the power is nearly zero as voltage is nearly zero. A solid state surge protector of this type can be made in a small package, constructed with a accurate voltage sensitive trigger, for application directly to the device being protected.

The solid state protector exhibits a high impedance when not triggered. It will not load or disturb a line. In the event of a failure of the protector, it will fail in the shorted condition assuring continued protection for expensive equipment. A maintainer can quickly locate a defective uit.

One precaution must be taken with this protector. As the device will remain conductive after being triggered as long as current flows it must be used only where it sees no sustained DC. This would include all AC or modulated DC applications where the voltage periodically drops to zero or reverses, or those applications where the DC component can be blocked with a capacitor.

This protector is used in conjunction with an arrester. This assures that the capacity is limited only to the extent that the primary arrester would be totally destroyed. The protector itself is thus well protected and can be expected to last as long as the associated arrester is intact.

The gas tube arrester consists of two or more electrodes in a glass envelope filled with a gas more easily ionized than air. To further help in ionizing the gas in the gap, a radioactive substance is sometimes used in the vicinity of the electrodes.

These gas tubes are not capable of dissipating energy as in an air gap arrester because they are confined by the glass envelope. The rapid gas expansion in a large surge can rupture the glass. They should be used only as a back up to an air gap or bleeder type arrester. It is also necessary to introduce impedance in the circuit to limit surge currents.

We have primarily been concerned with surges from line to line, however, we must also consider surges from line to ground.

Although measures are usually taken to isolate equipment from ground, it is often mounted on a wood shelf or back board which is not a perfect insulator as pertaining to voltages of 1,000 or greater. Furthermore, the chassis of the equipment is capacitively coupled to the shelf and the case or the bungalow. In all solid state equipment the manufacturer must design not only for good isolation of the circuit from the chassis, but also arrange the circuit to minimize capacitive coupling from the components to the chassis and cover.

It is is of perhaps greater importance with solid state equipment to have a good and effective ground than with relay-type logic.

Communications challenge lies ahead in areas of data transmission

By B. L. Arnold
Sales Engineer
Lenkurt Electric Co., Inc.

Many of the desires and ideas you have had to improve and expand your communication and signal plants are today a real possibility, both technically and economically.

This is the "crystal ball" area where you can add many ideas, but we are really talking about four main topics: voice, video, data and control. We intermix the terminology "data" with "voice" because many systems provide very high grade voice and data circuits. The increased use of higher speed data, or computer-to-computer talk going on today requires that we take portions of our useable baseband spectrum for machine talk.

The voice channel is the real workhorse of the system. It can be handled like a kitten with very delicate conversations which are highly secret or conversely, turned into a roaring lion with many sub-channels used to perform just about every conceivable job that man can think of.

Data is really synonymous with the voice facility since most of the channels used for data transmissions are derived from sub-multiplexing or dividing a VF (voice frequency) circuit. There is transmission equipment available for use in the voice band, all the way from two bauds to 4800/9600 bauds or bits per second.

Also, not to be overlooked, in your planning of either a microwave, radio, or high density cable system is the realization that you will be

Control usage

Control can be construed to mean a management directive, or to the actual operation of the railroad rolling stock automatically. The days of push-button operation, or pre-programmed and taped schedules of trains is already here.

- In the not too distant future the dispatcher will only monitor the control panels to determine the status of each section of a division, or several divisions of the road, and the progress of trains including other pertinent train information.

- The first step, of course, toward centralization of controls is the rebuilding of the communication and signal facilities. In recent years a far more cooperative attitude exists between the signal and communication groups, as well as the supplier of the various types of equipment. The next step is the centralization by area, of the present manual dispatching functions.

- What is being considered for centralized operation, whether it be data about customer accounts, car identification, or the actual operation of the trains, can also be applied to hotbox detection, initially set up on a local readout basis. At some time in the near future computers will decide whether it is a "go" or "no-go" situation.

- Automatic car weighing will also be injected into the computer to determine the number units of motive power required.

- Stockroom control of supplies and purchasing will come into its own as more information is computer handled on a real time and palletized basis.

- Information about motive power units, needs for additional horsepower by remote measurement of strains and stresses on the units while under power and relayed by wayside pickup devices can give a true picture of the performance of a unit or group of units.

- The expanded use of hotbox or journal data temperature devices and short and long haul transmission equipment, along with the remote control of mobile base stations has greatly improved dispatching operations and given them coverage and better control.

called on to handle some data speeds which exceed the logical capabilities of a normal or average VF circuit. Some of these will be one or two 20.4 kbs per base group (60–108 kHz) with a few 4 kHz VF circuits riding free of charge. In the more sophisticated layout, you may have 40.8 kbs requirements in a base group. These are being used regularly and are good workhorses of the computer-to-computer or tapedeck-to-tapedeck type layouts.

Another good application appearing on the horizon and currently being promoted in the common carrier industry is a wideband data facility, either on a private line, point-to-point multipoint basis, or on a dialed up subscriber basis. The latter is still a little distance away.

A new era is dawning with many new innovations. Some of you are going to say—"we'll wait until tomorrow for the latest before we start to revamp or revolutionize our system and operation". This is your mistake. While you wait it out, some new department will be formed around you, fencing you in while you reminisce about your past.

These changes in the state-of-the-art and how they apply to your particular system are progressive, and any program you plan should be spread over a reasonable period of time. It should not be left to your successor, because greater efficiency of operation, and the economic studies of top management will not allow it to wait. There is already on the horizon a coaxial cable system using pulse-coded modulation schemes capable of 10,500 channels (4-kHz) over a single pair of coax tubes.

Yes—repeaters or one-way amplifiers are required quite frequently. But, they are inexpensive and power requirements are low.

The present equipment you can be using provided you do your planning right to economically justify it, or can prove it to your management is 600, 1200, and 1800 channel cable carrier systems using conventional frequency division multiplex which, in many cases, will be compatible with your present multiplex equipment. And this is all available at reasonable costs.

Another application fast coming up on the scene is that of doubling or expanding the data handling capabilities of voice frequency sub-multiplexing channels. Doubling and

Data applications

- Message switching, either concentrator machine-to-machine, or machine-to-computer can be on a store and forward basis—45/75, 110, 150, 200, 600, 1200 baud operation. The last two are not to be considered as manual or real time operation (from brain-to-brain) as it is necessary to prepare a tape or some mechanical means of sending the information.

- Storage and retrieval of statistical information such as what many of you are now planning for your large management control system, is an important data application.

- Hot journal systems are now being handled on a manual decision basis mostly, or some preset differential for remotely stopping a train. This particular application should fit into the computer program.

- High, wide load detection has plagued railroads for years. The present approach is to tie it directly into the signal system, stopping a train if something is out-of-bounds. The possibility of transmitting this information to the control point along with wheel or car counting data would permit clearance information to be tied-in with the train consist.

- Snow and icing conditions, bridge, trestle or overpass damage, tunnel cavein, rock slides, moisture content of roadbed alarms, defective switch points and frogs, broken rails and out of alignment of track and grade crossing surveillance, broken flanges, dragging equipment, loose wheels, broken steam connections, etc., are only a few of the many uses of tone equipment, data transmission and control systems which are available in the VF range.

- Automatic car identification now being implemented, will provide a boost to railroads. Tools are available for transmitting over VF facilities, at 2400 bps direct from trackside scanner to the computer which, in turn, stores for record and future updating and retransmits at a slower or teletypewriter speed to a yard or other operating office. At the same time, keeping an on-demand record of the shipper car for future tracing.

ACI impact on communications and signaling functions

quadrupling the bit rate of data, telegraph, or control channels will open many new possibilities to you as aids in fully automating many phases of your operation.

The installation of composite cables along the right-of-way will allow removal of depreciated signal and code lines. It will also allow unlimited access to the railroad at a reasonable figure, while providing the very best in the way of service protection to both communication and signal circuits. Buried cable along the tracks may not be the best answer. There are several radio frequency bands that can be used for from 2 to 120 channel (4-kHz) bandwidths. Fully compatible equipment is available which permits direct interconnect, or interleaving side-log channels for VF, data, control, CTC, hotbox, and just about any service you may require at a remote hamlet, shipping dock or interchange point.

Video usage

This is an area relatively new to the railroads even though many have some form of closed circuit TV in yards, shops, warehouses, power stations, etc. It can have tremendous impact on the operations of a road.

- A video tape made in the nose of a locomotive on a continuous run basis would be extremely useful in case of a serious accident involving life and property.
- Remotely controlled inspection of inaccessible places, or isolated river bridges during flood and storm conditions.
- Slowed down, or digitalized video for verification of documents, signatures and still shots over every VF channel is a possibility.
- A recent development of one manufacturer of video tape equipment permits documents and other paperwork to be stored via video tape for ready retrieval either locally or through the communication facilities.

Real life problems are not always the topics discussed extensively but the sectional meeting at Cincinnati proved to be an exception. Problems associated with the implementation of ACI were discussed from almost every conceivable angle.

The number of suggestions as to how ACI can be used on a railroad are as varied as there are people involved. However, some of the more popular uses include:

- At the point where a train leaves a yard
- In approach to an interchange
- In conjunction with a weigh-in-motion scale.
- At an interlocking
- Within the limits of a joint facility

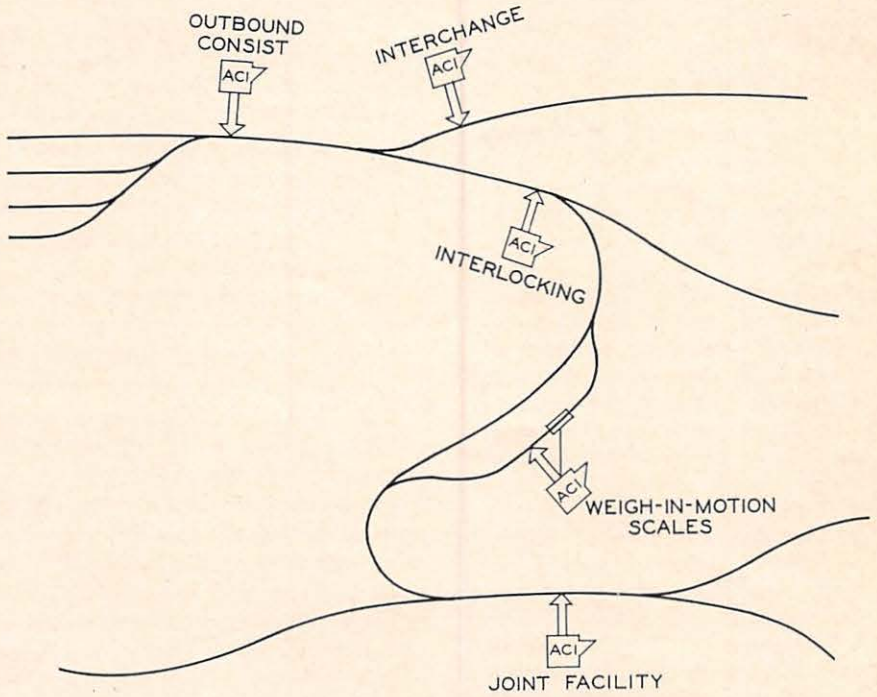
Where an outbound train passes an ACI unit at the output of a yard, it would automatically generate the outbound consist and would also verify that the train was made up of cars in the order shown. In most data systems as they exist today, this is not always the case.

Existing data systems usually have input locations for the primary purpose of capturing interchange and interchange delivered. "This is important", J. H. Wallis, director of C&S planning, C&O/B&O, said "because errors in our input for cars received will cause trouble as long as the car is on line. It causes further trouble in accounting functions which results in open records and additional expense in clearing them up.

"It appears possible that much of the equipment now used to capture interchange data will, in the future, be replaced by ACI," Wallis said.

The combination of ACI with weigh-in-motion scales appears to offer a degree of sophistication bordering on complete automation.

One such system is now working in a captive operation on the Penn Central. The ACI identifies coal hopper-car numbers as the train passes the scanner. The car initial and number is fed into a signal code converter. When the car passes over the scale the weight is read while the car is in motion and this is fed into the same code and signal converter. The entire operation is synchronized so that the car weight always appears on the printout following the



Automatic car identification scanners can be profitably located.

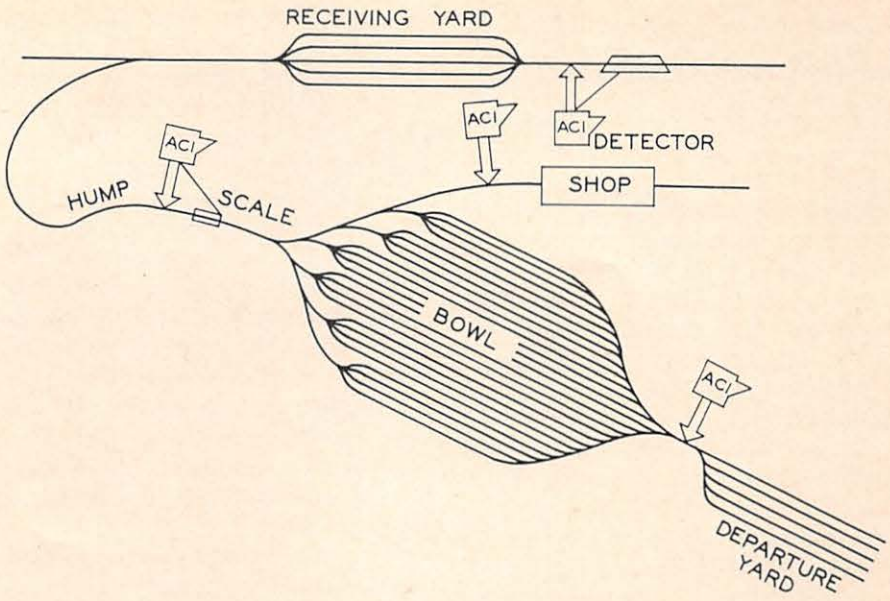
car number.

The output of both the scales and the scanner is transmitted over a private line teletypewriter service directly to the computer center at Philadelphia. The car number and the loaded weight of the car goes into the computer. The computer checks its file and produces a second report reflecting the net lading on each of the cars.

It was noted that the scales and scanners are at remote locations out in the "boondocks" and are providing a fast payoff for the Penn Central.

Scales are now under development that will weigh a train, not the individual car, at speeds of 35 or 40 mph. In addition to providing source data for customer billing and motive power assignments, conditions hazardous to high speed operation could be picked up by detectors working in conjunction with the equipment at these locations.

At interlockings ACI could serve as a count in, count out device. It would, under certain circumstances, be used to identify a train and set up the route through the interlocking. There are other ways of doing this, of course, but this is another approach.



ACI scanners can keep accurate track of cars in a yard area.

ACI units located in a joint facility territory, where two or more railroads share the facility and bill each other on a car or train basis, would provide an ideal way of accurately keeping records and simpify accounting.

In discussing ACI applications, it was projected that yards would be among the first places where the system would be used. It was pointed out that with an ACI scanner at the entrance to the yard the consist and sequence of cars could be determined as the train enters the receiving yard. The train can be classified

ACI questions and answers

How does the ACI system detect that there is no label on the car? How can it tell, in a train, that there is a car but that there is no label on that car?

The scanner knows that a car is there because it is detected by a sensor on the track which delivers an impulse for every wheel that goes by. When the wheel count indicates that a car has passed without the notice of the label, it is interpreted as being a car without any label.

Does this count four wheels?

It is a little more complex than just counting four wheels. Six-axle vehicles have been provided for where they are isolated in the train. When we begin to build up successive six axle vehicles an indication will be introduced indicating unlabeled cars. This is not 100% efficient, it does not take care of all of the conditions but will catch most of them.

Has a buffer been developed to make it possible for two railroads to share a scanner and associated logic?

A program has been initiated and it is anticipated that this equipment will be available sometime in 1969.

Would you elaborate a little on the lease arrangement as to how it applies to maintenance? With equipment leased by the railroad, can the railroad perform the maintenance?

No. All leased equipment must be serviced by Sylvania personnel.

With units all over the country will Sylvania be equipped to furnish satisfactory service on these units to avoid undue delay? What can we expect?

Sylvania is approaching the point where we expect to have approximately two hours to respond to a call. This is expected to improve as the number of the scanner increases.

What is the policy on maintenance of purchased equipment?

The railroad can maintain the equipment or it can get a maintenance contract with Sylvania who will maintain it. Sylvania conducts classes where railroads, who purchase equipment, can send representatives. These representatives will be instructed in maintenance of this equipment.

What is the possibility of joint facility service on some of these at various railroad interconnections?

That could be a good application. On one railroad a study indicated that instrumentation for ACI would serve both properties.

Could both properties interrogate this unit and get their own information out?

I think this is entirely possible. This will, of course, simplify interchange procedures. It will establish the interchange time, it will also definitely establish that the car was at this interchange point at the specified time and did pass over at this point to the other carrier. Transportation people have been studying this to determine how it will affect interchange rules and bookkeeping.

Are the technicians who maintain this equipment required to have a radio license?

No.

without delay and with this information a computer could be programmed to handle the humping operation automatically. It was even suggested that a method could be devised to pull the pins using ACI to verify the location of the cut, eliminating errors.

Various uses were described to utilize ACI in the bowl section of the retarder yard, but in any event it was determined that ACI, by itself, will do very little unless it is coupled into a suitable data processing system. It is one element that can be tailored into the system design to provide accuracy of input data.

Communications links for ACI

At the Cincinnati meeting one speaker indicated that data systems people are probably more interested in ACI because "it is an information system and it is an input to the data processor." It was pointed out, however, that "only a small portion of the information goes into a processor or comes out of it."

"This in itself is the key," R. V. Impey, data planning engineer, American Telephone & Telegraph Co., said. Communications men are involved in many phases and Impey urged that for technical and economic reasons the two groups must work together to gain optimum results.

Communications men will find that there are a lot of options available to tailor the ACI system to fill a particular need. What are some of these options? Impey asked.

First, it is necessary to look at how many characters you are going to put on a line and at what speed the information will be transmitted. The basic label provides for 10 characters, however, that makes no provision for spaces and other digits.

The carrier index option gives one the opportunity to print out the information in numeric form. Characters are changed to alpha characters. There is also a message generator that adds a prefix or suffix to the message. This, in effect adds more characters to the line. This can be done when the train is in its approach so that by the time a train reaches the scanner the system is ready for the label information.

If you have piggyback, you are not reading one label, you are reading three labels. For a car you are now adding a minimum of 36 characters. Eventually it will be necessary to add a character return, a line feed and the figure shift. That will add three more characters. If you have a weigh in motion system there are four more characters and actually, you can have up to 17 characters per car or label.

You can see that in such a system you can have any number of characters on line for one 40 ft car. This in effect could regulate the speed of the train.

What you must look at is how many characters per car is going to be put on a line. This is the factor that will determine transmission speed.

Using a simplified system—scanner, decoder, code converter and serializer, in a real time situation you can read directly as a train passes and it can then be transmitted directly to the computer. At the present time there is a 5 level baudot or 8 level ASCII for real time operation at 60 or 100 wpm.

Any number of options can be made to operate in a real-time mode up to the full capability of the scanner.

Taking the 100 wpm, 5 level baudot—which is about as fast as you can do—the speed of the train would be about 15 mph. One can easily see that the communications system has, in effect, limited the speed of the train. This is with a single label 40 ft car. If the speed of the train must be greater, something must be done about the communications link.

What can be done about it? The speed of the train can be increased by putting in voice grade data sets, on private line and transmit the information at almost any desired speed. This, however, is where economics become involved. If you want to transmit at 2400 baud you must look at the economic trade off of a 2400 baud line and data sets compared to a buffer.

I think these are the perogatives of communications men, not those of data systems, Impey said.

It may be decided that a buffer should be installed to enhance the system and add the capability to read a train as it passes at 80 mph. A tape buffer can read about ten 200-car trains, store it and transmit it at any desired time. What is the buffer going to cost? Should it be a tape buffer, a disc, or core type buffer? Buffers have different capabilities too. The magnetic tape buffer can read at almost any speed but it can only read out at 20 characters a second. You really haven't accomplished anything so far as speed or cutting down the time that the line is associated with the process.

If you desire a system that transmits and will also report on request, a buffer and an interface control unit will be needed. A selective calling system can only operate if the information is stored in a buffer. There is no way on a real time system to go back and retrieve information.

Impey pointed out that a Bell System data phone data set 401H can be set at trackside with the decoder and can originate the call by itself. That is, when the train has passed it will automatically trigger the data set, which has a number generator. It will call the computer and tell it that a train has passed and that it has the information available. It can, through a reverse channel, let the computer tell it that it didn't receive all of the information correctly, or that it would like it over again and it will repeat it. The 401L is not yet completed, but when ready it will be capable of being polled by the computer. This would appear ideal for a location where there is only one train a day and the information is not vital at any particular time. The computer, over the telephone line, will be able to call that station and ask for the information.

Panel discusses C&S problems

It appears that we are entering an era where C&S systems cross craft lines. It is anticipated that this could cause some difficulty unless those problems associated with both installation and maintenance are

worked out beforehand.

Some roads have experienced problems with the divided responsibility of maintaining hotbox detector equipment. It has been found that where one department is responsible for the entire function the equipment is beter maintained. One superintendent of signals pointed out that where two or more crafts are responsible for a system it is very easy to "attribute trouble to the other party and calmly go about other duties, thinking that they will take care of it".

A great deal of concern was expressed about who should be assigned the work but it was generally agreed that whoever gets it, should receive a corresponding updating of the budget.

Are we telling a complete story to our management? was one question raised. With all of the new developments and expansion into solid-state technology, conditions are changing rapidly. It was pointed out that signals installed in the early 1900's are still doing the job they were designed to do and there is a fixed maintenance charge that goes with them. The state-of-the-art is changing. Much of the current system will soon be obsolete.

If obsolencence is taken into consideration, one S&C engineer questioned lower maintenance costs. The new solid state equipment is not like a semaphore signal that will work for 40 years. The new equipment is doing an excellent job but components installed just a few years ago are now fading out of the picture, the engineer pointed out. "We can't stand in the way of progress but let's make sure the complete story is told." The new technology is available "and it can be used to furnish better service to the public. That is what we are here to do. It is coming but we can't put a dollar and cent figure on it."

Strings on state and federal aid

The cost of maintaining equipment installed with financial assistance from state and federal agencies was discussed to some length. The question was asked: "how long can we keep adding this equipment and maintenance costs?" It is difficult to answer such a question but it was determined that costs are much too high and that while some of the initial cost of installation of such equipment as crossing protective devices may be absorbed by the state and federal government, maintenance costs have been and will remain a responsibility of the railroads for some time to come.

"It is inescapable that most rail crossing accidents are caused by human failure arising from noncompliance by the drivers with laws and regulations," said H. A. Linderer, superintendent safety and rules, Frisco

Taking the Frisco as an example, Linderer pointed out the need for more crossing protection but explained that the cost ranges from $10-35,000 to install with an annual maintenance cost of about $60. The Frisco has nearly 5,000 crossings. Some 600 have been equipped with automatic signals.

"The railroad would be bankrupt if it were required to assume all or even a substantial part of the cost", Linderer declared.

Action is being pressed in at least four fields in an attempt to help the railroads prevent grade crossing collisions, Joseph H. Hays, general counsel, Association of Western Railroads said.

To summarize, efforts are being made:

- to close unnecessary crossings and the public financing of an increased number of grade separations or eliminations;
- to improve education and indoctrination of motor vehicle drivers;
- to establishment of improved advance warning systems as motor vehicles approach grade crossings; and
- to achieve better compliance by motor vehicle drivers with existing laws and regulations which bear upon driving at grade crossings.

"The Department of Transportation has established a task force with personnel from both the Federal Railroad Administration and the Federal Highway Administration. Its sole purpose is to discover what can be done to prevent grade crossing accidents and to stimulate action to accomplish that end.

"One sure way to prevent grade crossing collisions is to eliminate the crossing. Each railroad is urged to survey its own property at regular intervals at least once every two years, in order to identify crossings, either private or public, which can be closed to highway traffic. Each road is urged to resist the opening of new crossings without clear proof of real necessity.

"States are urged to establish grade crossing funds to aid road and street authorities, particularly as to local roads and streets, in financing protection or separation structures. Eight states have established grade crossing funds. In most states money from the grade crossing fund is available for only protective devices on only local roads or streets.

"The ICC has found that the cost of protecting automotive traffic as it flows over railroad tracks is a public responsibility.

"The railroad industry has formally adopted the position as a matter of policy that Federal aid should be provided to states and local units of government to help them pay for both the installation and maintenance of grade crossing protection, not only on Federal highways, but on state and local roads and city streets as well. The explosive growth in motor vehicle use and in motor vehicle speed have made federal aid necessary if we are to make motorists stop killing themselves at grade crossings," Hays declared.

Private line radio

By H. R. Rupp
Application Engineer
Motorola Communications & Electronics, Inc.

Consider a railroad yard radio system with several crews on the same channel. Put yourself in the position of the locomotive engineer on a switching job with a conventional carrier squelch two-way radio. You would hear something like this:

"903 move ahead six car lengths."

"900 move your cut off the main."

"OK"

"Say, Joe, where is the bad order car?"

"The bad order is B & O 72637."

"That's cut of three Casey; kick it into the rip track area."

"Hey, stop at six lengths, not sixty."

Sectional Meetings

Which of these messages is intended for you? Only one! There is no reason for you to hear all of them.

Many roads rely on a private line receiver to accept messages that originate within the users own system and blocks messages from other systems operating on the same frequency.

In the conventional carrier-squelch radio system, the loudspeaker is turned off until the receiver detects an incoming RF carrier signal. In the tone-coded squelch system, the receiver must detect both an incoming carrier and the proper tone code, before you can hear the message. The controlling element in tone-coded squelch is a resonant reed. Like a tuning fork, this reed is resonant at only one frequency.

In railroading it will soon be necessary to turn to a selective method of separating subsystems on the same channel. Private line makes the sharing feasible.

Vibrasender reed, has a private line transmitter which controls an oscilator circuit. The oscillator produces the sub-audio coded tone—and it keeps generating the tone as long as the transmitter is on.

In the receiver, at the other end of the system there is a vibrasponder reed and its circuit. When the receiver picks up a signal with the proper tone-code, the vibrasponder circuit will open the audio circuit and the message will get through to the loudspeaker. If the incoming signal has no tone, or if it doesn't have the correct tone, the vibrasponder circuit won't allow this message to get through.

When the coded tone opens the receiver, you don't hear the tone itself. You hear only the message. This is because the system's audio response range is 300 to 3000 Hz. The private line tone—which is below 300 cycles—never gets to the loudspeaker. Private line systems can be operated near each other on a single channel. And since the vibrasender and vibrasponder reeds are plug-in units, a system can be changed from one tone frequency to another. Several private line systems can operate on one channel.

Motorola and the Illinois Central recently conducted tests at a yard in Chicago to determine the effect of capture in the use of a private line yard radio system.

The test showed that the threshhold point of capture of a 2 watt portable was 800 ft from the interfering locomotive when the hand-held portable was only 25 ft from the desired locomotive. But this 32-to-1 ratio has many variables. For example, if a loop antenna is used on the portable, the signal strength varies with the direction of the propagation. Multipath reflections from metal railroad cars and buildings have either a supporting or subtracting effect.

In normal railroad operations, the man on the ground with his two-way radio will direct the activities of the locomotive. The engineer responds with action, rather than a verbal response and then action. For example, to couple two cuts of cars, the man on the ground might say, "903, move south three car lengths." 903 moves south three car lengths, then waits for the next request from the man on the portable. The switching locomotive engineer would rarely use his radio transmitter, although he would use his receiver regularly. Therefore, if the locomotive receiver would be captured, it would probably be by a portable in another system.

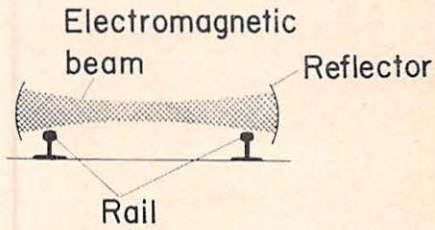
To get a practical idea of how this works, two private line-equipped portables on the same channel transmitted to receivers in locomotives 800 ft apart. Portable A transmitted to locomotive A, portable B transmitted to locomotive B, and we looked for the threshhold point of capture. Capture of locomotive A's receiver occurred when the interfering portable, B, was 550 ft (about 13 car lengths) from locomotive A; and portable A was 250 ft (about six car lengths) from locomotive A.

When studied on the basis of radio waves in free space, these tests show that it is possible for independent systems to operate within the same yard on the same RF channel. **RS&C**

Railway Cybernetics

Japanese National Railways has been experimenting with means to detect obstacles in the track area which would be dangerous to oncoming trains. JNR engineers* report that their work is concerned with automatic detection of obstacles on the track other than trains at places other than at highway grade crossings.

Experiments are being carried out with three prototype devices. One is a surface waveguide installed between the rails. An electric wave of 30 cm is radiated from the train or on-track vehicle. The electric wave is transmitted on the surface waveguide, and a part of it is reflected by the point where there is an obstacle and is returned to the vehicle or the approaching train.



Electromagnetic beam waveguide system.

Experience over the testing period (1957-1962) has been that when the peak output of the transmitter is 50 kw, a detecting distance of 3 km (about 1.87 miles) is feasible. However, the detecting range (in the direction perpendicular to the rail) is limited within 30 cm, including the top part of the surface waveguide. This is due to the fact that the

* *Toshihiko Itoh, Deputy Superintendent, Tokyo Railway Machinery and Rolling Stock Inspector's Office, and Kyoji Tsubouchi, Assistant to Chief, Signal Section, Electrical Engineering Department, Japanese National Railways. Abstract from paper presented at Second International Symposium on the use of Cybernetics on the Railways, Montreal, Que.*

Q and A: private line radio

Can the private line system be disabled so that it can receive any signal?

Yes, simply by pushing a button or flipping a switch. The reed tones can be replaced because they are mounted in plug-in units.

Can private line system be added to existing radios?

Generally no. Some radios can be converted in the field, however, most are too difficult to work with to make the necessary modifications in the field.

What happens when you have two radios in the same channel transmitting at the same time? What does the receiver pick up if both are on the private line channel?

Whether or not the receiver receives the transmissions depends on two things: Is the receiver equipped with the mating code and then on the signal strength of the transmitter.

If the signal strength of one transmitter is twice as great as the signal strength of the other the larger one will take over. The signal strength not only depends on the transmitter power but also the distance.

While the receiver is open will it receive anything else that is going on on that frequency?

No, provided signal strength is twice as strong as interfering signal strength. All that private line does is keep the receiver squelched or keep the receiver turned off to unwanted signals.

top part of the waveguide cannot be above the top of rail. Also, the installation of the surface waveguide between the rails makes it difficult to perform track maintenance.

From 1964 to 1966, a leaky waveguide (see diagram) was installed on both sides of the rails. The electric wave is radiated from one guide and the leaky wave is received by the other guide. If there is any obstacle present, the electric wave is cut off, and it is turned into a receiving wave, thus enabling detection of the obstacle.

At the beginning, a waveguide using a millimeter wave of 6 mm wave length was experimented on the prototype. As a result, the coupling coefficient, or the coupling loss of the prototype waveguide was found to be −90 dB per meter (about 3 ft) and the attenuation constant to be 4.75 dB per km (0.625 mile).

Experimental results indicate that in the case of transmission and reception on the ground, a detecting distance of 3 km (about 1.87 miles) is practicable at a peak output of 10 kw. If the device is well adjusted, the detecting range will be constituted by a space 10 cm (about 4″) in height above the rail level and 3 meters (about 9 ft) in width. The size of detectable obstacles will be 30 cm (about 12″) in length in the direction of the rail.

In the case of the wave length being 6 mm, even a slight variation in the geometrical relative positions of the waveguide and the wave reflector affects the transmission characteristics a great deal. As a result, a waveguide in which a centimetre wave of 3 cm is used, the detecting power is stabilized, but the size of the detectable obstacles becomes about 1 meter (3 ft) in length in the direction of the rail.

An obstacle detector in which a leaky waveguide is used is fail-safe in principle and its detecting power is reliable, but it is somewhat expensive compared to other detector systems under development.

A third type of detector system makes use of an electromagnetic beam waveguide installed on both sides of the rails. Electric wave transmission is carried out by utilizing the space between the guides. If there is any obstacle, the reflected wave comes back, and thus it can be detected.

Compared with the leaky waveguide system, this system is less expensive. Field testing of the electromagnetic beam waveguide was carried out last year, but results are not yet available. In this system, JNR engineers had planned to use an electromagnetic wave of about 13 cm. **RS&C**

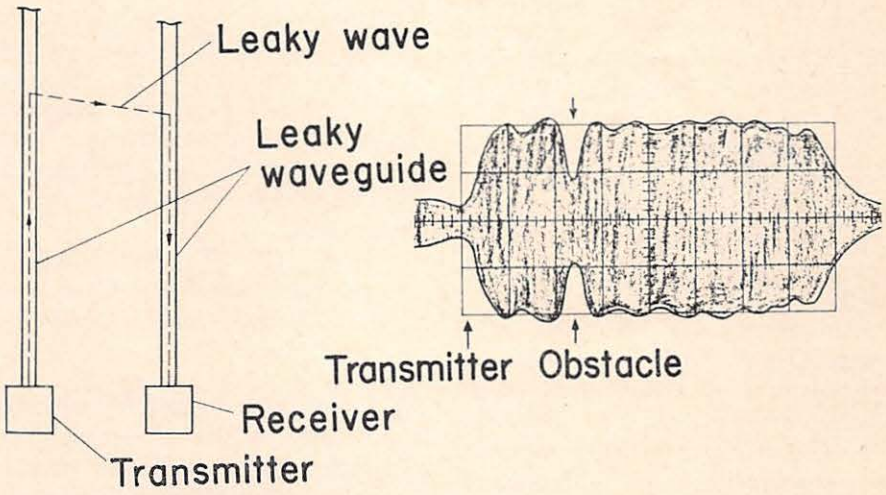
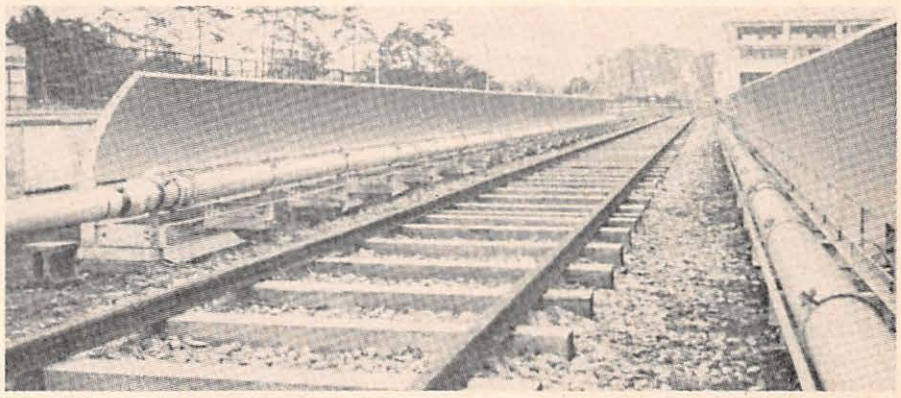


Diagram of the leaky waveguide system.



Leaky waveguide system as installed for test on JNR.

Feedback

Microwave and Rain

Q. Does rainfall affect microwave signals and if so, at what frequencies does attenuation and noise effect become noticeable? At what frequencies are they most pronounced?

A. Energy at microwave frequencies travel through the atmosphere in relatively straight lines similar to light waves. These are reflected by large flat surfaces and are also scattered by rain or fog. Attenuation of microwave signals is caused by scattering and not by absorption.

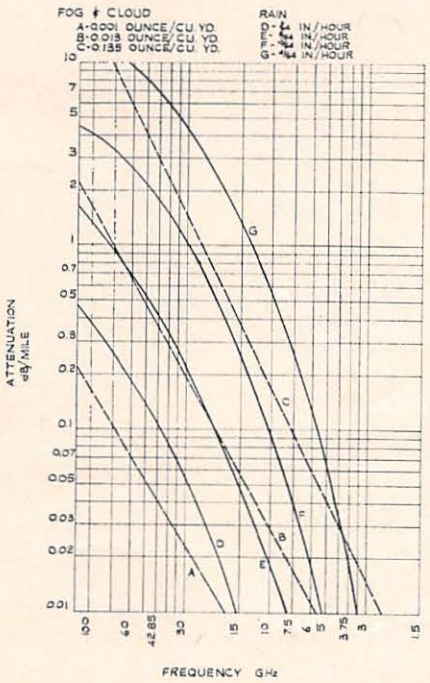
Long haul microwave radio systems are designed to make use of frequencies in the 6000-7000 mHz band. Attenuation to rain at these frequencies can be ignored in most cases. Referring to the attached drawing, a rainfall of 0.6" per hour would result in an attenuation of 0.1 to 0.3 dB per mile. Such heavy rainfall is not normally widespread to the entire area existing between two microwave stations, so that the loss would not be noticeable provided sufficient fade margin has been designed into the system.

The dielectric constant of dry snow is much less than rain. Therefore, the influence of snow is negligible.

Attenuation in the frequency range above 10,000 mHz increases with frequency. These frequencies are often used in radar to detect the presence of cloud or precipitation in the atmosphere for weather reporting.

C. D. Marlatt, Supervisor of Communications, Pacific Great Eastern

A. Rainfall does affect microwave propagation in that it attenuates the signals, particularly in the higher frequency bands, that is, 12.5 gHz. We have not found that rainfall, regardless of how heavy it might have been, is sufficient to disrupt the operation of transmission in the 6.75 gHz region. Also, we have not had conditions that could be identified where this attenuation was great enough to cause an increase in the noise factor on the system provided



PGE: Marlatt—Attenuation vs frequency.

the system was previously designed with at least 40 dB of fade margin.

In the frequency of 12.5 gHz extremely heavy rain will attenuate the path to the extent that the path will occasionally be interrupted. This condition will exist even on short paths.

L. R. Thomas, General Superintendent Communications & Signals, Santa Fe

A. Since each individual raindrop approaches in size dimension approaching the wavelength and is resonant to the extremely high radio frequencies (frequencies in the order of about 8 gHz and higher), severe microwave propagation losses are encountered when rainfall is experienced in such microwave paths. In these instances, each raindrop absorbs microwave energy and dissipates the absorbed energy in some other form, heat primarily. Noise caused by such microwave paths is prevalent at a microwave receiver in proportion to signal strength degradation when signal levels are lower than the microwave receiver noise level design criteria.

N. C. Pace, Assistant to Vice-President-Communications, Southern

A. At frequencies between 4 and 8 gHz the attenuation effect of precipitation is so slight that no additional fade margin is required beyond that normally provided for reliability against interference type fading. In almost all cases, precipitation is accompanied by winds that minimize stratification and attenuation fading.

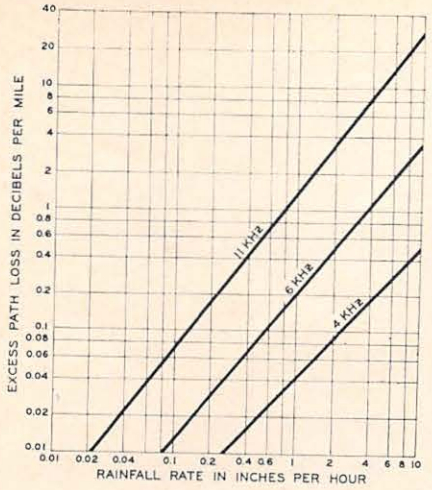
However, in the 11 gHz band attenuation from rain becomes a definite factor as propagation at 11 gHz differs from that at the lower frequency bands chiefly in its vulnerability to rain.

The effects of rain on microwave radio propagation have been calculated by Ryde and Ryde. The radio energy is absorbed and scattered by the rain drops, and these effects become more pronounced at the higher microwave frequencies where the wavelength and the raindrop diameter become more clearly comparable.

A number of good references are available on this subject particularly: (1) J. W. Ryde and D. Ryde, "Attenuation of Centimeter Waves by Rain, Hail, Fog and Clouds" General Electric Company, Ltd., Wembley, England, May 1945. (2) J. W. Ryde, "The Attenuation and Radar Echoes Produced at Centimeter Wave-lengths by Various Meterological Phenomena," Pages 169-188 in "Meteorological Factors in Radio Wave Propagation," The Physical Society, 1946. (3) Howard E. Bussey, "Microwave Attenuation Statistics Estimated from Rainfall and Water Vapor Statistics," Proceedings I.R.E. July 1950, Pages 781-785.

H. M. Robertson, Assistant to Superintendent Communications, Union Pacific

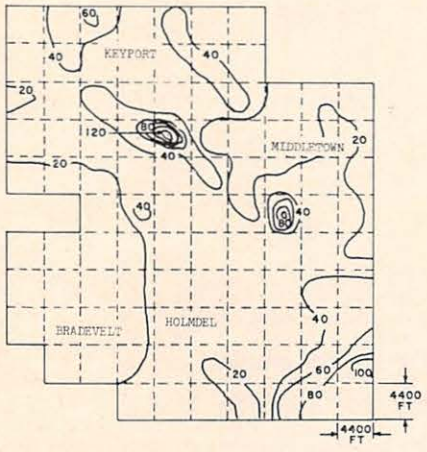
A. Engineers have developed equipment which scans rain activity every ten seconds at 100 points in a 50-square mile area surrounding Bell's Crawford Hill Laboratory at Holmdel, N.J. The system continuously measures rainfall and stores the data on tape for computer analysis. Rain activity information gathered by the system shows whether a shower is general or local, the dimensions of showers and storms, and the movements of areas of varying rain density.



UP: Robertson—Rain attenuation vs rainfall rate (theoretical, after Ryde and Ryde). Attenuation is expressed in excess path loss in decibels per mile. Rainfall rate is in inches per hour.

Earlier studies at Bell Labs have shown that rain in the path of a microwave beam may scatter and attenuate the signal in a variety of ways depending upon the signal wavelengths, as well as on rain drop size and density of rainfall.

Information on the size, severity, and distribution of rainstorms at ground level is essential for the planning of any microwave systems in the 10 to 100 gHz frequency range. With such information, it can be determined how far apart microwave transmitters and receivers should be spaced, and what alternate route might be taken within a storm-blanketed area. While such system planning is highly important for terrestrial radio links, it could be particularly critical when continuous communications must be maintained with a spacecraft. Attenuation and noise effects from rain become noticeable at frequencies of about 6 gHz, but they are pronounced at frequencies above 10 gHz.



Bell Telephone Labs

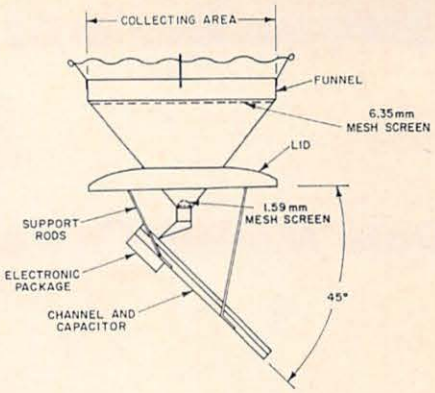
An example of one 10-second sample of data for a storm is shown here. The rainfall rate contour lines are in millimeters of rain per hour (25.4mm = 1 inch). Note the spatial variability of the rain rates.

Previously available rain measuring equipment was unable to detect sudden changes in rates of rainfall, and presented formidable problems of collecting data from any large array of gauges. With the Bell Labs system, a vast amount of data is collected by an array of 100 continuously-measuring rainfall rate gauges mounted on telephone poles approximately 4400 ft apart. The information from the gauges is transmitted to the Crawford Hill Laboratory over telephone lines leased from the New Jersey Bell Telephone Company.

The present project is yielding interesting and surprising results. Measurements taken seconds apart in a rainstorm, for example, show a wide variety of rates at a single gauge as well as simultaneously at the 100 gauges. This indicates that rain is not evenly distributed but comes down "in bucketfuls" which appear to drift about while other areas have relatively less rain. This may be the pattern described in folklore as "walking rain."

In each rain gauge in the new system, rainfall is funneled into an inclined channel which runs between the electrodes of a capacitor. Changes in the volume of flow are measured by the capacitor, which in turn causes variations in the frequency of a signal produced by an oscillator on the telephone line. The 12" long capacitor flow meter, with a signal-producing electronic package attached, is able to sense and rapidly measure rain activity from the first drop to rates in excess of 10" per hour.

When rain is expected, the control and recording equipment is turned on either at the Crawford Hill Laboratory or remotely by dialing a telephone number. The rain gauges are scanned every 100 seconds, although no data are recorded until rain actually begins to fall. At the first drop of rain in one of the gauges, the scanner is automatically switched to high speed, completing each scan in only 10 seconds, while recording the data on tape.



Bell Telephone Labs

The continuously measuring rainfall rate gauge designed at Bell Telephone Laboratories, Holmdel, N.J. is shown in this drawing. Rainfall is intercepted and measured as water volume flowing down a 45 deg inclined plane in a channel between the electrodes of a capacitor. As the volume of water changes, it is reflected as variations in the frequency of a signal produced by an oscillator connected to a telephone line. The 12"-long capacitor flow meter, with a signal-producing electronic package attached, is able to sense and measure rain activity from the first drop to rates in excess of 10" per hour. Structurally, the gauge is a large galvanized gasoline funnel welded through the lid of a galvanized can. The can is mounted on a telephone pole and serves to protect the capacitor and electronic package when the lid is in place on the can. The bird deterrent (the loose wire around the top of the funnel) is not electrified, but is positioned such that it makes alighting on the funnel more difficult.

Once the recorded data have been converted into equivalent rainfall rates, they become part of a cumulative study of ways to improve the reliability of communication systems. In addition to studying microwave transmissions through the storms along adjacent paths, computer generated maps showing rain rates over the area are made as an aid to determining the spatial extent of the storm. Also, computer generated movies can be made to permit real time studies of rain activity. Thus, the use of the rain gauge array in a given area over a significant time span is expected to provide vital information for planning and constructing microwave systems.

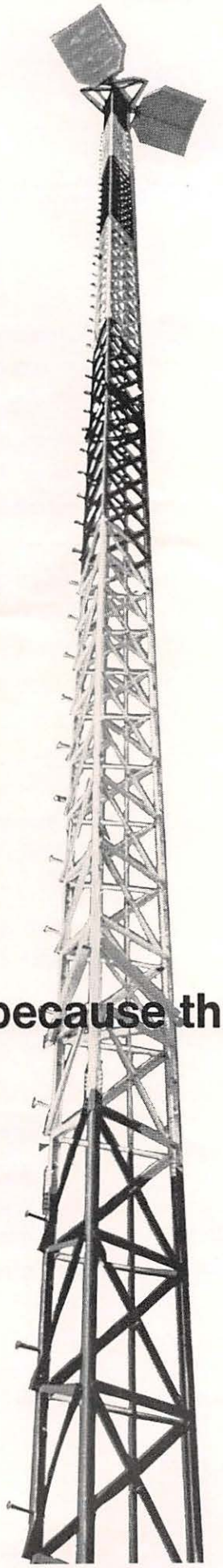
Bell Telephone Laboratories

Data Modem Characteristics

Prepared by Leo J. Ritter, Staff Engineer, Communications & Signals, Penn Central. Reprinted by permission of George McCann, Secretary, Communication & Signal Section, AAR.

Manufacturer	Automatic Electric	Automatic Electric
Model	AE 401-E	AE 401-J Data Set
Transmit and/or receive	Transmit	Receive
Full and/or Half Duplex	Full or Half duplex	Full or Half duplex
Dial up or Private Line Application	Dial or Private Line	Dial or Private Line
Turn around time (HDX)	Not Applicable	Controlled by data eqpt
Automatic answer capability	Not applicable	Yes
Type modulation	Multi-frequency	Multi-frequency
Operating Frequencies	600-2350 Hz	600-2350 Hz
Clock, internal or external	None	None
Loop back testing feature	No	No
Error rate	Depends on facility	— — —
Error detection and/or correction	None	None
EIA RS-232-B interface	Yes	No
Bit or character rate	20 chars/sec	20 chars/sec
Serial or parallel transmission	Parallel	Parallel
Impedance to line, ohms	900	900
Impedance to data equipment, ohms	EIA RS-232-B	Contact closure
Voltages to and from data equipment	EIA RS-232-B	Contact closure
Frequency stability	— — —	0.5%
Level stability	— — —	±1 db
Output levels to line, dbm	−12	— — —
Input levels from line, dbm	Not applicable	Min. −44
Line requirements, frequency response	Voice grade, to 2.8 kHz	Voice grade
Line requirements, envelope delay	Voice grade, to 2.8 kHz	Voice grade
Line requirements, impedance	Voice grade, to 2.8 kHz	Voice grade
Line requirements, signal to steady noise	Voice grade, to 2.8 kHz	Voice grade
Line requirements, signal to impulse noise	Voice grade, to 2.8 kHz	Voice grade
Method of operation	2 wire	2 wire
Temperature and humidity limits	— — —	−20 to +120 deg F
Power requirements	— — —	117 volts
Dimensions and weight	— — —	6" x 18" x 10", 15 lb
Digital or analog	Digital	Digital

RCA
Microwave
Communications



They won't shut up because they won't shut down

After 23 years of designing and installing microwave, 95% of all RCA-equipped stations are still going strong.

RCA microwave just never seems to wear out . . . and we have 23 years of operating experience and thousands of microwave stations to prove it. From small one-hop systems to cross-continent, high density networks, RCA microwave is an around-the-clock performer—transmitting voice, data, telemetry and supervisory control signals.

And it's 23 years better today. That's because today's RCA microwave is total solid state design (an RCA first), which means no tubes to burn out and no relays to fail. Heterodyne operation (RCA pioneered that, too) brings in clear signals, eliminates distortion.

If you are planning a microwave system, shouldn't you look into RCA microwave ? Send for literature, or better still, request a planning consultation with an RCA microwave expert. He will show you what a difference 23 years of experience can make. Write RCA Microwave, Dept. M-248, Bldg. 15-5, Camden, N.J. 08102.

Here are just a few leading organizations who rely on RCA Microwave:

American Electric Power
California Division of Highways
Chicago & North Western Railway
El Paso Natural Gas
Empire District Electric
Santa Fe Railway
Shell Oil

Data Modem Characteristics

Prepared by Leo J. Ritter, Staff Engineer, Communications & Signals, Penn Central. Reprinted by permission of George McCann, Secretary, Communication & Signal Section, AAR.

Manufacturer	Automatic Electric	Automatic Electric
Model	AE 403-C Data Set	AE 403-E Data Set
Transmit and/or receive	Transmit	Receive
Full and/or Half Duplex	Full or Half duplex	Half duplex
Dial up or Private Line Application	Dial or Private Line	Dial or Private Line
Turn around time (HDX)	Controlled by data eqpt	Controlled by data eqpt
Automatic answer capability	— — —	Yes
Type modulation	Multi-frequency	Multi-frequency
Operating Frequencies	600-2350 Hz	600-2350 Hz
Clock, internal or external	None	None
Loop back testing feature	No	No
Error rate	— — —	— — —
Error detection and/or correction	None	None
EIA RS-232-B interface	No	No
Bit or character rate	20 chars/sec	20 chars/sec
Serial or parallel transmission	Parallel	Parallel
Impedance to line, ohms	900	900
Impedance to data equipment, ohms	Contact closure	Contact closure
Voltages to and from data equipment	Contact closure	Contact closure
Frequency stability	0.5%	0.5%
Level stability	±1 db	±1 db
Output levels to line, dbm	−9	— — —
Input levels from line, dbm	— — —	Min. −44
Line requirements, frequency response	Voice grade	Voice grade
Line requirements, envelope delay	Voice grade	Voice grade
Line requirements, impedance	Voice grade	Voice grade
Line requirements, signal to steady noise	Voice grade	Voice grade
Line requirements, signal to impulse noise	Voice grade	Voice grade
Method of operation	2 wire	2 wire
Temperature and humidity limits	−20 to +120 deg F	−20 to +120 deg F
Power requirements	Furnish by line	— — —
Dimensions and weight	4″ x 10″ x 8″, 3 lb	6″ x 18″ x 10″, 15 lb
Digital or analog	Digital	Digital

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Systems available from Cable Communication Systems, Inc. employ cable and electronic transmission equipment to provide simultaneous transmission of voice, telemetry, control and data information. These proven cable systems combine long life and high reliability with years of low maintenance, low cost operation. CCS systems are supplied as complete turnkey installations ready for use. Our product folder gives the CCS systems story. Write: Cable Communication Systems, Inc., 79 Sidney Street, Cambridge, Massachusetts 02139. Or call (617) 547-9000.

Cable Communication Systems, Inc. is a jointly owned company utilizing the technologies of the Simplex Wire and Cable Company and CIT-Compagnie Industrielle des Télécommunications, a subsidiary of CGE-Compagnie Générale d 'Eléctricité.

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News Briefs

• BROTHERHOOD OF RAILROAD SIGNALMEN have received certification by the National Mediation Board to represent communication maintainers and communication foremen on the Kansas City Terminal.

• CHESAPEAKE & OHIO/BALTIMORE & OHIO will spend more than $1.6 million to modernize the 130-mile line between Ashford, N.Y. and Punxsutawney, Pa. CTC will be installed with portions of second main track remaining as passing sidings, and some 64 miles of second main will be removed. Control will be from a machine at Punxsutawney. Work on the project, soon to begin, will take about two years.

• ILLINOIS CENTRAL will centralize its dispatching functions. Men from Waterloo, Ia., Vicksburg, Miss., Paducah, Ky., Memphis, Tenn., Carbondale and Champaign, Ill., will be transferred to Chicago. The changeover will take about two years. H. F. Davenport, assistant vice-president, operation, said: "Improved telephone service via the railroad's new microwave network will make it possible to keep the dispatchers in immediate touch with all parts of the system. Dispatchers at the six outlying points will move to Chicago at railroad expense," Davenport said. "In all, about 80 dispatchers and clerical workers will be affected by the centralization." He estimated a net reduction of only 10 positions across the system through the next two years, all by attrition. "After the men have moved to Chicago, they will still work the same territory they do now. They will talk to the same operators and yardmasters as at present, except they will be better informed about the railroad's entire operation," Davenport said.

• LEHIGH VALLEY has received approval from the Federal Railroad Administration of DOT to install a traffic control system between Cementon and Bethlehem, Pa., 11.7 miles.

• NEW YORK CITY TRANSIT AUTHORITY has awarded a $4 million contract to the Signal & Communications division of WABCO for a complete renovation of all signaling and interlocking equipment on the IRT Lenox avenue line between 96th street and 145th street in New York, borough of Manhattan. Interlockings at 110th, 135th and 141st streets will be controlled from a machine at Lenox avenue yard. Included on the console will be a track diagram to indicate progress and position of all trains operating between 95th street and Lenox avenue yard.

NYCTA has placed in operation its two-way radio system that links 4,200 buses with their headquarters. The radios, RCA Super-Fleetfones, are part of a $4.2 million contract that calls for delivery of 4,772 solid-state design sets for installation in buses and patrol vehicles, 253 portable two-way radios as well as 19 base stations.

• WISCONSIN ELECTRIC POWER CO. has ordered a remote manual inductive coupling control system for an unmanned locomotive from the Signal & Communications division of WABCO for installation at the Oak Creek power plant, south of Milwaukee.

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Railroad Personnel

• ELGIN, JOLIET & EASTERN: **Toney R. Reynolds** has been appointed to a newly-created position of communication and electrical engineering technician with headquarters at Joliet. Mr. Reynolds recently graduated from DeVry Institute of Technology.

• FEDERAL RAILROAD ADMINISTRATION: **Howard R. Longhurst**, deputy director, Bureau of Railroad Safety, has retired. Mr. Longhurst was formerly assistant director of the ICC's Bureau of Safety and Service and chief of the Section of Railroad Safety.

• METROPOLITAN TRANSPORTATION AUTHORITY: **William B. Garrison**, recently appointed transportation engineer, was born in Lodi, Ohio on Oct. 24, 1935. He graduated from Case Institute of Technology in 1957 with a bachelor of science degree in electrical engineering. He joined New York Central in 1957 as an engineering assistant in the signal department. Three years later he was appointed an assistant engineer, and in 1961 Mr. Garrison was promoted to electronics engineer. In 1964, he was promoted to project engineer, communications and signals. Three years later, he was appointed design engineer, communications and signals, the position he held with Penn Central, when he resigned in April to join MTA.

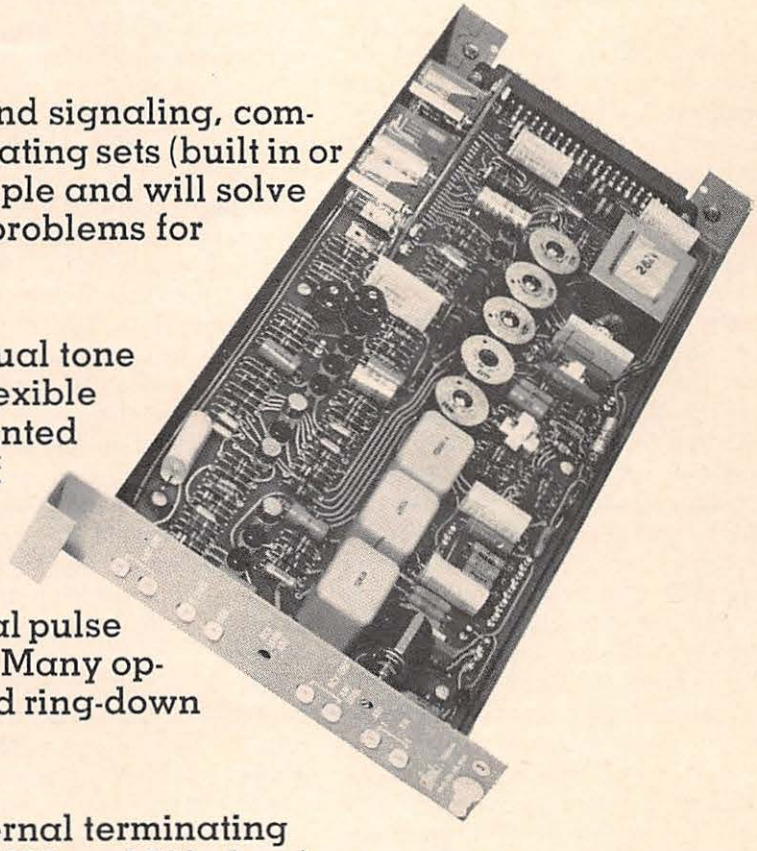
Supply Trade News

• COPPERWELD STEEL CO.: **Andrew Pudlak**, manager of industrial sales, Wire & Cable division, has been appointed area manager, export, covering South East Asia, Australia and New Zealand.

• THOMAS A. EDISON INDUSTRIES: Primary Battery Division—**Peter J. Salerno**, field engineer, Chicago, has been promoted to assistant western regional manager, there. Mr. Salerno was born in Passaic, N.J., on Oct. 1, 1910. He joined Okonite

(Please turn to page 36)

Inband Signaling and Terminating sets: Graybar/Lynch can arrange the perfect marriage.



Lynch B850 transistorized inband signaling, combined with Lynch coil type terminating sets (built in or external) make a compatible couple and will solve your signaling and terminating problems for 4-wire/2-wire applications.

The B850 series feature individual tone generators for economical and flexible installations. 12 units may be mounted in a 19" shelf occupying only 7" of height. And for a new dimension in reliability, Lynch has reduced "talk-off" probability to less than one in 10,000 completed calls. "Dial pulse correction" standard on all units. Many options available for E & M, loop and ring-down applications.

For applications requiring external terminating sets, the Lynch 2TN15 and 2TN16 (600 and 900 ohms) are recommended. These units utilize "89" type pads (resistors) for easy gain adjustment. Lynch coil type terminating sets will meet all requirements for toll-grade termination.

For any communication problem, call your Graybar Communications Specialist. He will be happy to tell you more about these or any other products for your communication system.

GraybaR
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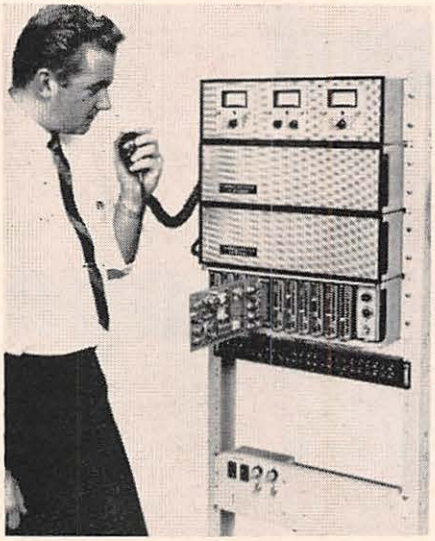
Circle 18 on reader service card on page 38

Product News



Radio Relay

A completely solid-state, radio-relay system for 100F9 transmission designed for the small channel capacity allocated in the 952 to 960 mHz band provides up to five two-way speech channels for remotely-controlling VHF base stations or other circuits that require toll quality speech channels.

The FCC recently type-approved this radio equipment for fixed station operation in the land-mobile services that include public safety, aviation, industrial and land transportation. A radio relay terminal consists of the new frequency division multiplexer, type 29A, and the new radio transmitter-receiver type 22B. The multiplex accepts up to five separate channels of audio signals that have information content below 3,400 Hz. For each channel, the multiplex converts the audio to a single-sideband-suppressed (SSB) carrier signal, each in a different 4 kHz band starting at 4 kHz and ending at 24 kHz. These SSB signals then phase modulate the radio relay's carrier. The resulting FM signal is transmitted. Output power from the completely solid-state system is 2 watts.

At the distant station, the type 22B receiver demodulates the FM transmission to recover the multiplexed, single-side-band signals. These, in turn, are separated and converted back to the original voice or control signals. All carrier frequencies are generated from crystals that are oven-controlled to insure stability.

In addition to the information on control signals, each channel can simultaneously transmit a 3,825 kHz frequency tone generated internally by the system. This tone can be keyed on and off for dialing or ringing in private telephone circuits or for actuating push-to-talk relays in the base station of a mobile radio system.

The equipment also includes a service channel which permits full communications between maintenance personnel at different sites. In a private telephone system, it can be used for order wire communications. For convenience, the service channel is equipped with a built-in microphone and loudspeaker.

A unique duplexer can be added to the system so that only one antenna and coaxial cable are needed for simultaneously transmitting and receiving signals. Without the duplexer, two antennas are required. In duplex operation, the radio's transmitting and receiving frequencies are separated by 3.6 mHz.

The system generally operates off a 120 or 240 volt AC power line but is also designed for standby battery operation. Circuits for charging the batteries are available as an option. Other options include failure alarms, E&M signaling in the service channel, metering panels for facilitating tune up and monitoring, and transfer panels to switch to emergency standby units.

Silicon transistors are used exclusively so the terminals operate reliably over a wide temperature range. *Cardion Communications. Circle 101 on Reader Service Coupon.*

Switch Heater

New type RTS Rail-Tel gas switch heater offers increased combustion efficiencies through improved inspirator design and utilizes aluminum and stainless steels throughout for minimum seasonal maintenance. Also improved is type RT. *Rails Co. Circle 102 on Reader Service Coupon.*

Primary Battery

A new add-water carbon battery, type F, uses a unique system to dispose of the normal zinc electrode reaction products. Basically, this system involves the crystallization of these reaction products on feather-weight fibers placed in the lower part of the battery, away from the electrodes. The Crystalaire is easily and quickly activated; has extremely uniform voltage and has complete reliability of operation over a wide range of temperatures.

The type F Crystalaire has a normal voltage of 2.5 volts and is rated at 1300 a.h. with up to 10% reserve capacity for emergencies. The recommended maximum continuous current of the type F is .250 amp. In the very low temperature ranges, such as —40F. deg., it will sustain a continuous current of .100 amp for six months or more at an average voltage of about 2.35 volts.

The type F Crystalaire battery is the same size as the types 2-S-J-1 and 2-S-L-2 Edison Carbonaire batteries. Hence it can be used in existing battery boxes.

The standard Edison Carbonaire carrying handle can be used for carrying the battery. Unlike Carbonaire batteries, however, the Crystalaire is shipped from the factory sealed in a water-proof plastic bag and can be stored in this condition for any reasonable length of time. There are no seals over the carbons or filler holes and no filler tubes to be removed. *Thomas A. Edison Industries. Circle 103 on Reader Service Coupon.*

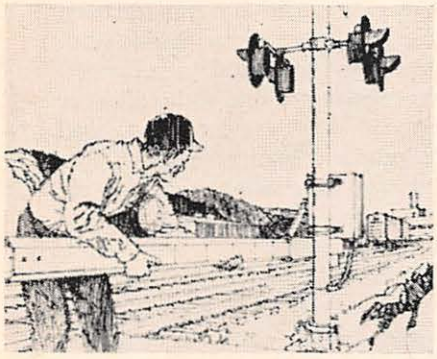
Inband Signaling

A new class of transistorized, 2600 cycle inband signaling equipment,

type B860 is designed especially for low density applications. Types of signaling available include: E&M dial, compatible end-to-end with the WE "E4B"; and foreign exchange, ground or loop start, compatible end-to-end with the WE "E1R and E1P".

Noteworthy features of the E&M dial signaling unit (8SU61A, option 1) include: an internal hybrid that provides superior return loss and transhybrid performance, accommodates trunks which require external grounding of the "F" lead in the trunk circuit and also provides back-to-back connection if required because "E", "F" and "N" leads are available; an adjustable transmit attenuator; all adjustments are front panel access; all line and drop level points are available for monitor.

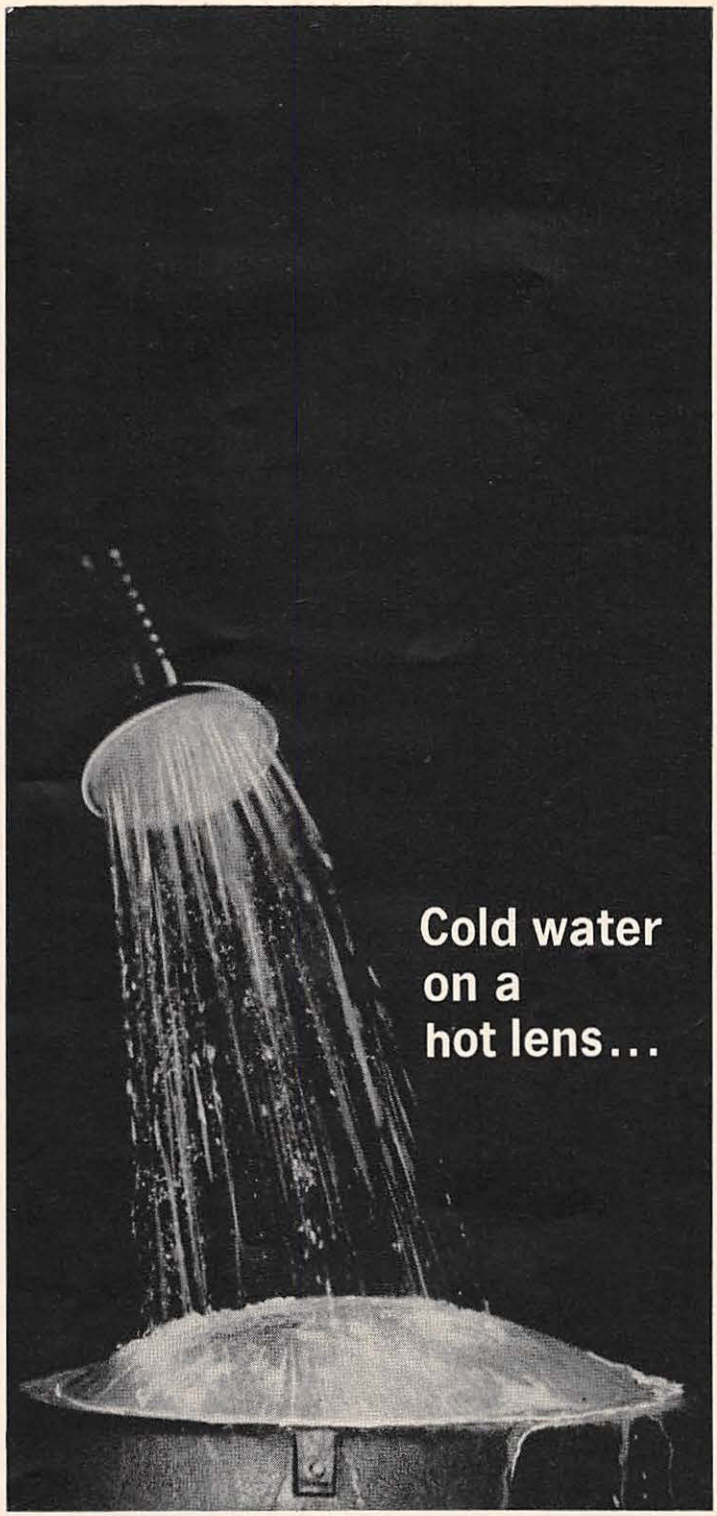
Lynch B860 signaling units contain individual built-in tone generators and a pre-wired, screw type terminal board to simplify in-the-field wiring, no soldering connections are required for installation. *Lynch Communication Systems. Circle 104 on Reader Service Coupon.*



Crossing Gate

A new light weight crossing gate designed for mounting on existing masts is equipped with three weatherproof bi-directional warning lamps and maintenance free 3" x 12" silver and red-orange retro-reflective strips to provide reflecting in all weather day or night.

An all-aluminum exterior requireing no painting, pre-lubricated and double-sealed bearings, and use of shear-bolts for gate mountings to minimize damage and allow easy replacement of gate arms are featured. This new gate meets or exceeds all AAR requirements. *Signal & Communications Division, WABCO. Circle 105 on Reader Service Coupon.*



. . . That's one way to test thermal shock resistance of a piece of glass. Careful testing through every step of production is one more reason why Kopp meets the toughest specifications in molded industrial glass. When you need glass, count on the experienced hands at Kopp.

KOPP GLASS

KOPP GLASS, INC., SWISSVALE, PENNSYLVANIA

Circle 14 on coupon page 38

(Continued from page 32)

William B. Garrison
Metropolitan TA

Peter J. Salerno
T. A. Edison

Co. in 1929 as supervisor of sales and service, and subsequently was appointed sales engineer specializing in railroad sales. In 1959, Mr. Salerno was appointed vice-president sales for T. George Stiles Co. In 1966, he joined Edison as a field engineer in Chicago.

• FABRI-TEK INC. is furnishing a core memory for Sylvania's Kar-Trak automatic car identification system. The random access core memory has a capacity of 8,192 words by 6 bits. It incorporates various conversion features that can store data on up to 10 average trains, for later transmittal, on command, to a central computer unit.

• FANSTEEL INC. is the new name of Fansteel Metallurgical Corp.

• GOULD-NATIONAL BATTERIES INC. has combined its alkaline battery division in St. Paul, Minn., with the recently acquired Marathon Battery Co., Wausau, Wis., into one division to be called the Gould Marathon Battery Co. **Donald P. Moen** will be president of the new company.

• KERITE COMPANY: **F. T. Sampson,** asst. western sales mgr. has been promoted to western sales manager, railroad division, with headquarters remaining at Chicago. **J. B. Fleer,** sales representative, has been appointed assistant western sales manager, railroad division, also at Chicago.

• MARQUARDT INDUSTRIAL PRODUCTS CO.: **Joseph V. Hoffart** recently appointed regional man-

(Please turn to page 38)

View from the Crossarm

• For the communications engineer, McGraw-Hill Book Co. has issued a comprehensive volume titled *"Communication System Engineering Handbook,"* that is more than a collection of basic data and the combined experience of the 33 experts who wrote it. The 25 chapters were written by specialists with AT&T, Bell Telephone Laboratories, GE, Lenkurt Electric, Motorola, RCA, and Western Union, to name a few. Railroad communications engineers will recognize the fine hand of J. Z. Millar, assistant vice-president, Western Union, who prepared chapters on telegraph switching methods and equipment, and data transmission equipment.

Five major sections in the book cover fundamental design considerations, system engineering, circuit engineering, engineering and construction af facilities, and scientific fundamentals such as switching, noise, coding and acoustical theory. Particular attention is given to data transmission closed-circuit television, potential address systems, and radio frequency assignment procedures. Of special interest is the chapter on cost study methods that deals with cost study types, nature of costs, time value of money and economic selection studies.

The 25 chapters are: 1—system design requirements; 2—user equipments and services; 3—speech characteristics and acoustic effects; 4—programming, probability and information theory; 5—communication system modeling; 6—transmission engineering of switched systems; 7—switching engineering of switched systems; 8—telegraph switching methods and equipment; 9—telephone switching methods and equipment; 10—multiplexing; 11—wire and cable transmission characteristics; 12—data transmission equipment; 13—closed-circuit television; 14—power-line carrier systems; 15—high-frequency communication circuits; 16—radio relay communication; 17—mobile radio services; 18—address communication systems; 19—radio-frequency allocation and assignment; 20—power for communication systems; 21—wire and cable installation practices; 22—central office configurations; 23—radio terminal configurations; 24—administration for communication systems; 25—cost study methods.

Communication System Engineering Handbook, Donald H. Hamsher, editor-in-chief, U.S. Army Electronics Command, published by McGraw-Hill Book Co., price $28.50.

• LEO G. SANDS ASSOCIATES, INC. has established a special training school for railroad personnel in New York City. The firm has laboratories and classrooms in Manhattan and has prepared accelerated courses in railroad radio maintenance, basic electronics and transistor technology. The courses run from two to six weeks and are conducted during business hours.

Elmer C. Carlson, school director, said that the railroad radio course leads to a Radio Telephone Operator's license. The transistor technology course is intended for signalmen who must be familiar with solid state electronics in order to maintain modern equipment.

Also, the firm can conduct classes at any location when it is not feasible to send railroad employees to New York. Carlson said the firm offers home study courses recorded on tape cassettes and include materials for conducting experiments plus a manual containing lecture illustrations and laboratory experiment instructions. For information write Training Division, Leo G. Sands Associates, Inc., 250 Park Ave., New York, N.Y. 10017.

Instant Power!

Fansteel Standby Power Systems assure instantaneous emergency AC standby power for communications and control systems. Protects against power loss or phase shift during a power failure. Fansteel Static SCR Inverters operate from 24-, 48-, 125-volts, or 250 volts d-c . . . or from single phase and three phase a-c. Fansteel Ⓟ Battery Chargers provide fast recharge after power is restored.

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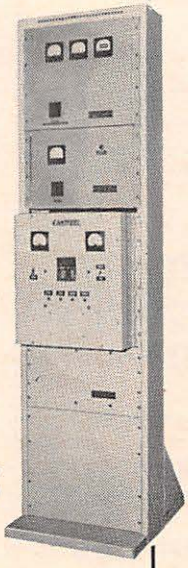

Static SCR Inverter in Standby Power System

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Rectifier Products

FANSTEEL INC.
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NORTH CHICAGO, ILLINOIS 60064

Circle 15 on reader service card on page 38

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The main track needs positive protection. No available means of guaranteeing its security should be omitted.

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Hayes Derail—the most universally used track device. Designed and built by men whose only business is railroads.

Free leatherette ring-binder catalog of world's most-specified derails, bumping posts and wheel stops (including periodic supplement sheets). Write on letterhead.

Specialists since 1903 in side track security

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Circle 16 on reader service card on page 38

Advertisers' Index

American Pamcor Inc. 37

Cable Communications Systems, Inc. 31
C & D Batteries, Division of Eltra Corp. 6
Copperweld Steel Company 3

Du Mont Mobile Communications Div. 10

ESB, Inc., (Exide Industrial Div.) 4

Fansteel Metallurgical Corp. 37

General Railway Signal Co. 9
Graybar Electric Company 33

Hayes Track Appliance Co. 37

Joslyn Electronic Systems, Div. of Joslyn Mfg. and Supply Co. 11

Kerite Company, The ..... FC
Kopp Glass, Inc. 35

Lenkurt Electric Company, Subsidiary of General Telephone & Electronics 8

Marquardt Industrial Products Co. 7

RACO (Railroad Accessories Corp.) ..... IFC
Radio Corp. of America, Microwave Dept. 29

Secode Electronics ..... IBC
Simplex Wire & Cable Co.—
Cable Communications Systems, Inc. 31
Stromberg-Carlson, A Subsidiary of General Dynamics Corp. 12

Western Railroad Supply Co., Div. of Western Industries . BC

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†Trademark of American Pamcor, Inc. *Trademark of AMP Incorporated

api† AMP*

(Continued from page 36)

Joseph V. Hoffart
Marquardt

Merrill H. Wilson
Marquardt

ager-communications, was formerly associated with the Signal & Communications division of WABCO as a sales engineer in the Chicago office. With an education in electronics, he had held engineering positions with the communications department of Great Northern.

Merrill H. Wilson, appointed manager systems engineering, was formerly associated with GE, Westinghouse Electric, ITT-Kellogg, and Bendix Radio. His most recent position, prior to joining Marquardt, was that of communications sales engineer on the headquarters sales staff of Signal & Communications Division of WABCO.

Larry Wanschek, recently appointed manager of engineering, began his engineering career with Electronic Communications Equipment Corp. in 1955. Five years later, he joined Sun Electric Corp. as assistant to manager of engineering.

Ed Dalman, recently appointed manager product development, joined Canadian Aviation Electronics as an engineer in 1958, after receiving a master's degree in electronics engineering. He joined the radio engineering section of Bendix

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Larry Wanschek
Marquardt

Ed Dalman
Marquardt

Marshall A. Williams
Simplex/West

John P. Matthews
WABCO

Corp. in 1960. Three years later he joined the Signal & Communications division of WABCO as a senior communications engineer.

• MODERN INDUSTRIES INC. has been appointed exclusive U.S. distributor for Fansteel's railroad signal products. MI is located in the Louisville Space Center at Fairdale, Ky.

• SIMMONS-BOARDMAN PUB. CORP.: **Ronald M. Giallonardo,** district manager at Pittsburgh, has been appointed regional sales manager, there. **William J. Lyneis** has been appointed district manager at the Chicago office.

• SIMPLEX/WEST INC. is a new subsidiary of Simplex Wire & Cable Co., with headquarters in Compton, Calif. The new firm will be responsible for the marketing of all Simplex products in 12 western states including Alaska and Hawaii. President and general manager of the new firm is **Marshall A. Williams,** who has been marketing vice-president of Simplex.

• SYLVANIA ELECTRIC PRODUCTS INC.: **George C. Connor,** senior vice-president, has retired, after more than 34 years of service. Starting as a receiving tube engineer in 1934, he advanced through many positions in engineering, marketing and administration. Since 1966, he served as president of Sylvania Rail Data Corp., and was active in the advancement of Sylvania's KarTrack ACI system.

• WABCO, Signal & Communications Division: **John P. Matthews** has been appointed sales engineer in the Western region office at Chicago. He joins WABCO from the Great Northern where he had several years experience in communications and electronics.

Railway Signaling & Communications

14 E. Jackson Blvd., Chicago, Ill. 60604
Attn: R. W. McKnight

Reader Service Card 7/68

Circle numbers for more information about products and services. **1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51**

101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130

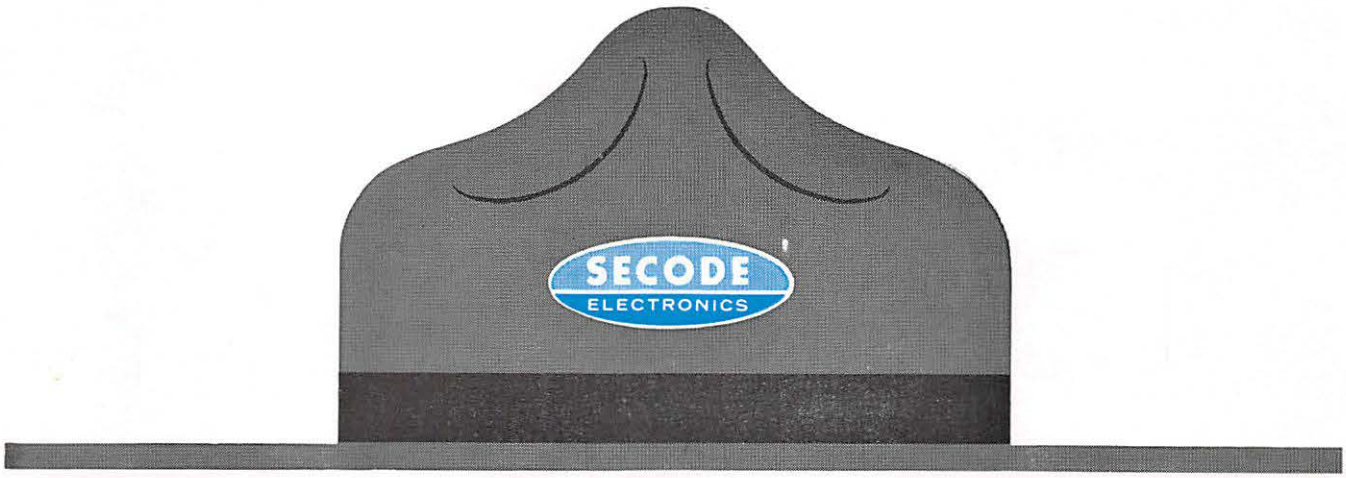
NAME .....

TITLE ..... RAILROAD .....

ADDRESS .....

CITY ..... STATE ..... ZIP # .....

THIS COUPON MUST BE USED ON OR BEFORE SEPTEMBER 30, 1968

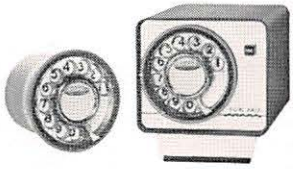


ALWAYS GET YOUR MAN!

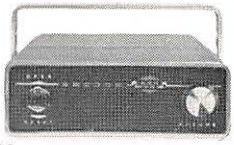
Mobile radios are more effective with selective signaling. If the man you seek is on the other end of a 2-way radio, mute his speaker and ring his bell, light his light, honk his horn . . . Secode always gets your man!

Turn off co-channel and intermodulation interference. Block out skip. Get better attention when you need it with a discrete code address digital signaling system by Secode. Let Secode help you get your man — signal us.

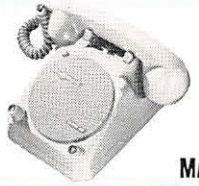
VP-1



TGS 735 M1 TGS 740

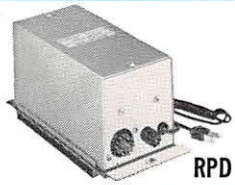


SD-30



MARK 60

SD 2 DS



RPD 673

CIH 7A

SECODE
ELECTRONICS

A Division of Communications Industries
908 Dragon Street • Dallas, Texas 75207
Phone 214/742-7231

Circle 2 on reader service card on page 38

WESTERN'S NEW AND PROVEN

Precision Filament

4,000 HOUR LAMP CUTS CHANGE OUTS BY 75%

GUARANTEED NOT MORE THAN 5% BURN OUTS IN 4,000 HOURS AT FULL RATED VOLTAGE

FROM NOW ON you need never again sacrifice light output for longer filament life, by burning lamps at less than rated voltage.

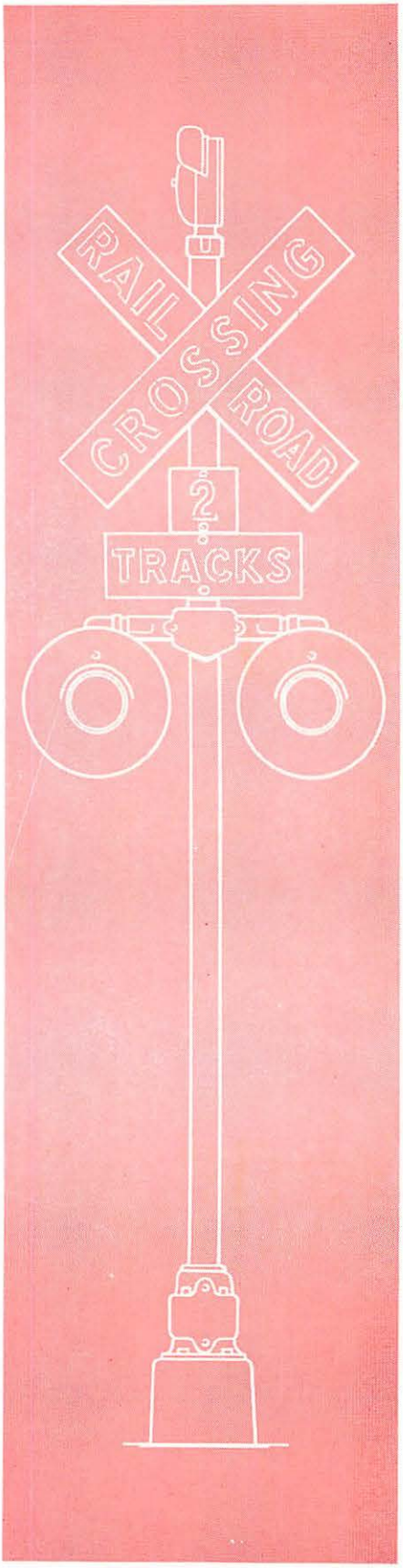
Western's new incandescent electric lamp, Type 90840, will burn a minimum of 4,000 hours at full rated voltage, with no more than 5% burn out.

This lamp is interchangeable for use in most signal lights, wherever lamps with S-11 bulbs are now in service.

LAMP SPECIFICATIONS:

Ordering reference: Type 90840
Light center length: 1¼ inches
Bulb: G-12, clear
Filament: CC-6
Base: Single contact bayonet
Rating: 10-Volts, 18-Watts

Now . . . for brighter lights, longer life . . . Specify the Type 90840



WESTERN RAILROAD SUPPLY COMPANY

Division of Western Industries, Inc.

2742 West 36th Place • Chicago, Illinois 60632

CANADA: Lyman Tube & Supply Co., Ltd., 5420 Pare St., Montreal 9, Quebec

3991

Circle 3 on reader service card on page 38